The Vote With the Wallet as a Multiplayer Prisoner's Dilemma*

Leonardo Becchetti†

Francesco Salustri‡

– This draft: 8 June 2015 –

Abstract

Socially responsible consumers and investors are increasingly using their consumption and saving choices as a "vote with the wallet" to award companies which are at vanguard in reconciling the creation of economic value with social and environmental sustainability. In our paper we model the vote with the wallet as a multiplayer prisoner's dilemma, outline equilibria and possible solutions to the related coordination failure problem, apply our analysis to domains in which the vote with the wallet is empirically more relevant, and provide policy suggestions.

Keywords: Corporate Social Responsibility, Multiplayer Prisoner's Dilemma, Voting with the Wallet.
JEL Classification: C72 (Noncooperative Games), C73 (Stochastic and Dynamic Games; Evolutionary Games; Repeated Games), D11 (Consumer Economics: Theory); H41 (Public Goods), M14 (Corporate Culture; Social Responsibility).

1 Introduction

The vote with the wallet is a phenomenon of growing relevance in the contemporary economic scenario. By *vote with the wallet* we mean the propensity of consumers to take into account in their consumption and saving choices not only price and quality, but also the social and environmental responsibility of sellers in order to stimulate companies to "retail" bundles of private and public goods (Besley and Ghatak, 2007) which may ultimately be in consumers' and investors' own interest (such as healthier food, better job opportunities, higher corporate fiscal responsibility).

*We would like to thank Andrea Attar, Marco Battaglini, and François Salanié for their helpful suggestions.

†Corresponding author. Dept. of Economics, Law and Institutions, University of Rome Tor Vergata, via Columbia, 2 – 00133 Rome. Email: becchetti@economia.uniroma2.it.

‡Dept. of Economics, Law and Institutions, University of Rome Tor Vergata, via Columbia, 2 – 00133 Rome. Email: francesco.salustri@uniroma2.it

In what follows we provide four examples of how the vote with the wallet is actually working. We do so to document the empirical relevance of the theoretical approach we develop in our paper. In the model outlined in the second section we then explain why the vote with the wallet is a special case of multiplayer prisoner's dilemma: each individual consumer has a positive externality when another consumer votes with the wallet, because the vote increases the public good benefit of a higher socially and environmentally responsible stance of sellers. The vote with the wallet may however imply an extra cost vis-à-vis buying a standard product. This extra cost may or may not be compensated by a third component, the intrinsic satisfaction produced by the buying action for that subset of consumers who have other-regarding preferences. These three basic ingredients of the game imply that free riding may be the optimal strategy under a reasonably wide range of parametric conditions producing a classical coordination failure problem, with a pure Nash equilibrium which is Pareto dominated by the strategy pair where both players vote with the wallet. The paper investigates various potential solutions to this coordination failure from one-shot two-player to repeated multiplayer games.

A first example of vote with the wallet in action is socially responsible consumption. The Global Report on Socially Conscious Consumers, one of the most extensive worldwide surveys on consumer choices (Nielsen, 2012), observes that 46 percent of the interviewed consumers are willing to pay more for socially and environmentally sustainable products. The share grows to 55 percent in the 2014 Nielsen Survey. Even though contingent evaluations as those mentioned above tend to be upward biased (Carson et al., 2001), actual market shares of products being traditionally object of the vote with the wallet document that the phenomenon exists and is relevant. One of the most interesting examples of it is fair trade (FT). Fair trade is a supply chain in which importers decide to transfer to marginalized raw material producers a higher share of value added than what otherwise would have been the case in order to finance their empowerment, skill upgrading and provision of public goods to the local community.[1] Sales of FT products which advertise their extra social and environmental content to the public have grown considerably in the last years in spite of stagnating consumption in high-income countries after the global financial

[1] For the literature on fair trade see, among others, LeClair (2002), Maseland and De Vaal (2002), Moore (2004), Hayes (2004) and Redfern and Sneker (2002).

crisis. They were 33 percent higher in Germany, 26 percent higher in The Netherlands, 28 percent in Sweden, 25 percent in Switzerland and 16 percent in the UK in 2012, compared to 2011. Empirical evidence documents that the vote with the wallet for fair trade products has triggered partial imitation of profit maximizing incumbents. Valuable examples are Nestlé[2], Tesco, Sainsbury, Ben & Jerry (Unilever)[3], Starbucks, Mars,[4] and Ferrero[5], with several institutions acknowledging the contagion potential of the vote with the wallet for fair trade products.[6]

A second channel in which the vote with the wallet is becoming particularly relevant in terms of market shares is that of professionally managed assets. The 2014 Eurosif SRI study release[7] reports that funds voting with the wallet by picking up stocks above a given SR threshold have grown by 91 percent between 2011 and 2013, up to an estimated 41 percent (€6.9 trillion) market share of European professionally managed assets. The most common voluntary exclusions are related to Cluster Munitions and Anti-Personnel Landmines (CM & APL) and cover about 30 percent (€5.0 trillion) of the European investment market, while voluntary exclusions not related to CM & APL cover about 23 percent (€4.0 trillion) of the market. In the same year the USSIF report finds that sustainable, responsible, and impact investing (SRI) assets expanded by 76 percent in two years up to $6.57 trillion at the start of 2014 (*Report on US Sustainable, Responsible and Impact Investing Trends 2014*) accounting for a market share of around 17 percent of all assets under professional management in the United States. A novel and relevant initiative in this direction is the Montreal Pledge[8] signed by a coalition of funds accounting for $3 trillion of assets under management. The initiative requires signatories "commit to measure and publicly disclose the carbon footprint of their investment portfolios on an annual basis" and to reduce pro-

[2] http://news.mongabay.com/2005/1007-reuters.html.

[3] http://www.mnn.com/earth-matters/wilderness-resources/blogs/ben-jerry-announces-big-move-into-fair-trade.

[4] http://www.mars.com/global/press-center/press-list/news-releases.aspx?SiteId=94&Id=3182.

[5] http://www.confectionerynews.com/Commodities/Ferrero-makes-Fairtrade-cocoa-commitment-after-rule-change.

[6] The EU Commission in its communication to the European Parliament on May 2009 acknowledged this contagion potential by declaring that «*Fair Trade has played a pioneering role in illuminating issues of responsibility and solidarity, which has impacted other operators and prompted the emergence of other sustainability regimes. Trade-related private sustainability initiatives use various social or environmental auditing standards, which have grown in number and market share*» (European Commission, 2009).

[7] http://www.eurosif.org/our-work/research/sri/european-sri-study-2014/.

[8] http://montrealpledge.org.

gressively their footprint providing a new frontier of application of the vote with the wallet.

A third relevant example of vote with the wallet comes from the Oxfam *Behind the Brands* campaign. In February 2013 Oxfam rated the 10 largest food multinationals by evaluating social and environmental responsibility of their supply chain on different domains (land, women, farmers, workers, climate, transparency, and water) in terms of awareness, knowledge and disclosure, commitment, and supply chain management. Oxfam then asked campaign supporters around the world to take action by voting with the wallet (buying products of highest rank companies) or sending ad hoc messages to the companies expressing their disappointment in case of low scores. At beginning 2015 nearly 700,000 actions had been taken and 32 major investment funds accounting for around $1.5 trillion joined Oxfam in asking the 10 biggest companies to improve their social and environmental stance. As a result of the campaign 9 out of the 10 biggest food companies took actions to improve their scores.[9]

A fourth vote with the wallet practice is that of "Community supported agriculture" (*Gruppi di Acquisto Solidale*). These small networks commit to buy directly from producers local agricultural products which are socially and environmentally responsible and compete with traditional distributors of traditional product chains with larger geographical extension.[10]

The four examples described above document that millions of people are currently playing the vote with the wallet game, and more so if we consider that also many of those who do not choose "responsible" products (as those included in the market shares described above) face in any case the alternative between standard and alternative products. Understanding how the vote with the wallet works exactly and how players can be successful in overcoming the related coordination failure problem is an interesting and still partially unexplored field of research.

[9] More specifically Oxfam reports that nine companies out of ten improved their scores from February 2013 to October 2014. Advancement concerned among others policies that commit to implementing the principles of Free Prior and Informed Consent (FPIC), women's rights, farmers, and environment.

[10] At March 2015 around 1600 solidarity based purchasing groups were present in Italy. http://www.retegas.org/index.php?module=pagesetter&func=viewpub&tid=2&pid=10.

The literature has analyzed so far in depth the supply side of the vote with the wallet phenomenon with oligopolistic models which investigate how companies compete for attracting socially and environmentally consumers. Besley and Ghatak (2007) outline a model where producers compete to attract socially responsible consumers by retailing "public goods"[11]. Other contributions (Becchetti and Solferino, 2011) document, under reasonable parametric conditions, that market entry of not-for-profit pioneers triggers (partial) imitation as optimal reaction of profit-maximizing incumbents, thereby identifying in the vote with the wallet one of the originating causes for the phenomenon of corporate social responsibility and for the above described contagion observed in fields such as fair trade. What is actually missing is a demand side analysis with a more in depth game theoretical inspection of consumers' interactions when voting with the wallet. On this side, Baron (2002) outlines a boycott model where individuals can first boycott a firm and then bargain private policy with the latter according to their preferences and available information. The vote with the wallet differs from the boycott for four reasons. First, while boycott typically reduces demand, the vote with the wallet is an action aimed at redirecting (and in many cases increasing, given the extra-cost of voting) consumer demand. Second, the vote with the wallet does not imply a bargaining process since individuals just reveal their preferences by consuming the products of their preferred firms. Third, the vote with the wallet is a practice that individuals do everyday by consuming, while boycotting is in general an extraordinary action that can be chosen under specific circumstances. Fourth, the vote with the wallet is a positive action which aims to reward the most "virtuous" firms creating emulation while boycotting is a negative action which penalises the worst firms. For these reasons, even though voting with the wallet for a "responsible" product implies not buying the alternative standard product, the vote with the wallet and boycott cannot be considered as symmetric problems.

Our paper provides a contribution on the vote with the wallet phenomenon. In what follows we argue that coordination among consumers voting with the wallet creates a typical mul-

[11] The industrial organization literature models competition in CSR by considering the latter an additional feature of the product (see, among others, Bagnoli and Watts, 2003 and Arora and Gangopadyhay, 1995).

tiplayer prisoner's dilemma (PD) with some qualifying characteristics that make the game unique. We then explore equilibria and potential solutions to the coordination problem from the simplest one-shot two-player up to the one-shot and infinitely repeated multiplayer games. More specifically, we outline conditions under which the prisoner's dilemma can be overcome with grim strategies in Folk theorems, Pavlov and proportional tit-for-tat strategies for evolutionary games, and with the identification and creation of coalitions of voters who adopt proper strategies to enforce the mutual voting equilibrium in the game.

The paper is divided into five sections (including introduction and conclusion). In the second section we outline the basic characteristics of the two-player one shot version of the game. We then illustrate its multiplayer extension and discuss how the PD can be overcome. In the third section we illustrate analytically in the repeated multiplayer game how Folk theorems and memory-one strategies in evolutionary games may enforce the mutual voting equilibrium. In the fourth section we examine the power of coordination illustrating how coalitions may enforce strategies which overcome the PD. The final section concludes.

2 The simplest model representation: a 2-player static game

In the simplest version of the game there are 2 players, $i = 1, 2$, who can vote with the wallet (V) or abstain from voting (A). The payoff for player i is

$$U_i(S) = \begin{cases} b + a - c \text{ if } S = (V, V) \\ \frac{1}{2}b + a - c \text{ if } S = (V, A) \\ \frac{1}{2}b \text{ if } S = (A, V) \\ 0 \text{ if } S = (A, A) \end{cases} \tag{1}$$

where $S := (S^i, S^{-i}) \in \{A, V\}^2$ is the strategy profile.

The payoff function (1) depends on three crucial factors: the public good benefit accruing from the voting choice ($b \in (0, +\infty)$), weighted for the share of players choosing the strategy V, the enjoyment arising from players' other-regarding preferences ($a \in [0, +\infty)$), and the extra-cost of voting ($c \in [0, +\infty)$).

The first factor (b) is the economic benefit accruing to the individual from the change in behavior of a company due to the vote with the wallet. This element hinges on the assumption that voters' actions have an impact on companies in proportion to the share of voters and can orient them toward a more socially and environmentally responsible behavior. Valuable examples of this benefit are higher chances of getting a job or higher job satisfaction in a more socially responsible company and health benefits or amenities from a more environmentally sustainable company. Other examples may relate to tax or cultural corporate responsibility. According to the first, consumers vote with the wallet for a company abstaining from tax dodging practices that reduce tax financed welfare services in their country. According to the second, they vote with the wallet for a company that finances with its CSR policies local cultural inheritance.[12] In all these cases it is reasonable to assume that the vote with the wallet produces an utility for consumers through a benefit which has public good features since it is clearly non-rivalrous and non-excludable (a socially, environmentally, fiscally, or culturally responsible company cannot limit the enjoyment of its responsible stance to consumers voting with the wallet excluding free riders who abstain from voting).[13]

The second factor ($a \in [0, +\infty)$) is contribution, if any, to the utility function of the voter if the latter has some form of other-regarding preferences, an element which has been demonstrated as not being uncommon in the experimental literature.[14]

[12] An example of cultural corporate responsibility comes from Expedia, Inc., a world's leading online travel company establishing a partnership of the World Heritage Alliance with the UNESCO World Heritage Centre. The World Heritage Alliance includes 59 corporate members and partners (such as the Fairmont Hotels and Resorts and Mandarin Oriental) which promote environmental, cultural and social responsibility, and support local community tourism initiatives at World Heritage sites with grants or by stimulating responsible tourists to contribute. The alliance is currently involved in the protection of 20 World Heritage sites in seven countries including Mexico, Costa Rica, Belize, Jordan, Dominica, Ecuador, and the United States. For other case studies of cultural corporate responsibility see (Starr, 2013) and Labadi and Long (2010).

[13] We consider b as exogenous for simplicity (and not related to oligopolistic models of CSR competition) since we focus on the consumers' perspective and it is reasonable to assume that the latter have their own approximate idea of the positive externality arising from the vote with the wallet and not a sophisticated knowledge of the competition model behind it.

[14] Empirical findings from Dictator Games (Andreoni and Miller, 2002), Gift Exchange Games (Fehr, Kirchsteiger and Reidl, 1993, Fehr, Kirchler, Weichbold and Gächter, 1998), Public Good Games (Fischbacher, Gächter and Fehr, 2001, Sonnemans, Schram and Offerman, 1999, Fehr and Gächter, 2000), Trust Games (Berg, Dickhaut and McCabe, 1995, Ben-Ner and Putterman, 2006), Ultimatum Games (Güth,

The third factor ($c \in [0, +\infty)$)[15] measures the cost of voting with the wallet, namely the extra cost, if any, paid by the consumer when choosing a product of a socially and environmentally responsible company vis-à-vis a product of comparable quality and lower price of another company which falls below the social and environmental standards of the former. We as well assume for simplicity that $Y_i > c$ for all $i = 1, 2$ (where Y_i is the income of player i), that is, all players' decisions to vote or not with the wallet depend only on utility considerations and are not constrained by lack of income.

The above described game can be represented by $G = (N, (S^i)_{i \in N}, (U_i)_{i \in N})$, where $N = \{1, 2\}$ is the set of individuals, $(S^i)_{i \in N}$ is the set of actions, and $(U_i)_{i \in N}$ is the set of payoffs described in (1). The payoff matrix writes

		Player 2: V	Player 2: A
Player 1	V	$b + a - c, b + a - c$	$\frac{1}{2}b + a - c, \frac{1}{2}b$
	A	$\frac{1}{2}b, \frac{1}{2}b + a - c$	$0, 0$

The game G has always a unique NE, which is (A, A) if $\frac{1}{2}b + a < c$, and (V, V) otherwise. The parametric conditions creating a prisoner's dilemma in the game are

$$\frac{1}{2}b + a - c < 0 < b + a - c < \frac{1}{2}b$$

or

$$\frac{1}{2}b + a < c < b + a \tag{2}$$

that is, when (2) holds, the (unique) NE (A, A) is Pareto dominated by the strategy pair

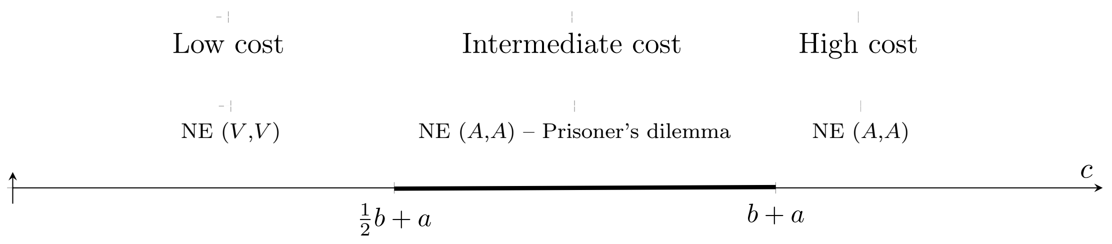
Schmittberger, and Schwarze, 1982, Camerer and Thaler, 1995) provide ample evidence documenting the existence of other regarding preferences. Evidence from behavioural studies highlights that individuals have other-regarding elements in their preferences ranging from (positive and negative) reciprocity (Rabin, 1993), inequity aversion (Fehr and Schmidt, 1999, and Bolton and Ockenfels, 2000), other-regarding preferences (Cox, 2004), social welfare preferences (Charness and Rabin, 2002), and various forms of pure and impure (warm glow) altruism (Andreoni, 1989 and 1990). A meta study of Engel (2010) examines results from around 328 different Dictator game experiments for a total of 20,813 observations. The result is that only around 36 percent individuals follow Nash rationality and give zero (based on these numbers the author can reject the null hypothesis that the dictator amount of giving is 0 with $z = 35.44, p < .00001$) and more than half give no less than 20 percent.

[15] Alternatively, it could be assumed that $c \in (-\infty, +\infty)$. However a negative c makes the problem trivial. Our theoretical analysis hence applies to the more frequent and reasonable cases in which corporate social responsibility tends to add extra costs.

(V, V) which yields the highest payoff for both players.

By considering b and a as product and individual characteristics respectively, and c as a parameter which may differ depending on the characteristics of the market under inquiry, the three regions of equilibria generated by different values of the cost of voting with the wallet outlined above are illustrated in Figure 1.

Figure 1: The three regions of equilibria along the segment of c values in the two-player game.



More specifically, given (2), we are not anymore in the PD region when the cost of voting is too high ($c > b + a$) or too low ($c < \frac{1}{2}b + a$) which could be the case of products with a relatively low (or zero) costs of voting (see our discussion in section 2.2 which follows).

Based on the above described features the originality of the game in the PD literature lies in its "hybrid" provision-PD game [16] characteristics where both the classical "cooperation" and "defection" strategies require an action. Another difference is given by the presence of a self-regarding preference argument adding a private benefit to the "cooperative" strategy which is typical of the vote with the wallet experience. As we will see in what follows these specific features and the framework of the game produce original attempts to overcome the dilemma (section 2.2) and original theoretical results vis-à-vis the standard provision-PD game in terms of interval of the PD's area (section 2.1), Folk theorem threshold patience (section 3.1), and renegotiation proofness conditions (section 4.2). The specific features of the game also produce an altruism paradox (section 4.1) which can be overcome with mechanism designs that are unique to the vote with the wallet framework (section 4.3).

[16] Arce and Sandler (2005) classify PD dilemmas into four categories (provision, commons, altruism, selfish) according to the private/public benefits and costs to players and to the action/inaction choices related to the "cooperation" and "defection" strategies.

2.1 The multiplayer game

When the number of players is $n \geq 2$, the game is represented by $G_n = (N, (S^i)_{i\in N}, (U_i)_{i\in N})$, where $N = \{1, \ldots, n\}$, $S^i = \{V, A\}$ for each $i \in N$, and the payoff function is

$$U_i(S^i, S^{-i}) = \begin{cases} \frac{j+1}{n}b + a - c \text{ if } S^i = V \\ \\ \frac{j}{n}b \text{ if } S^i = A \end{cases} \tag{3}$$

with j being the number of players who play V in S^{-i}. [17]

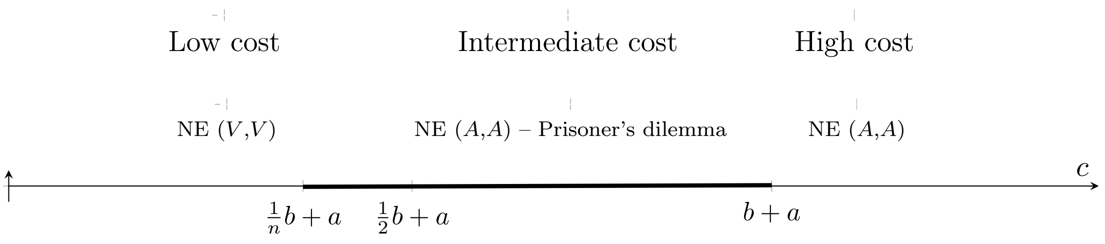
The game G_n has always a unique NE, which is mutual abstension if $\frac{1}{n}b+a < c$ and mutual voting otherwise.[18] However, if

$$\frac{1}{n}b + a < c < a + b, \tag{4}$$

we fall again in the PD and the equilibrium (A, A) is not efficient since, for both players, the highest payoff is $a + b - c$, which is obtained with the (V, V) strategy pair.

Figure 2 below clearly shows that the area of the prisoner's dilemma in the voting with the wallet game gets larger at the left side of the segment when the number of players grows. This implies that in standard global consumer markets where the number of players tends to be very large the (V, V) equilibrium can be attained only if the other regarding preference parameter is higher than the cost differential parameter for all players (i.e. $\lim_{n\to+\infty} \frac{1}{n}b + a = a$). As a result the PD is a highly relevant problem in the vote with the wallet game in presence of a high number of players and whenever the value of c is not negligible.

Figure 2: The three regions of equilibria along the segment of c values in the multiplayer game.



[17] S^{-i} is a $(n-1)$-dimensional vector over $\{V, A\}$, so j is a natural number in $\{0, 1, \ldots, n-1\}$.
[18] We prove this result in Appendix A.

2.2 Discussion and possible extensions to find solution to the vote with the wallet PD

Before looking at formal solutions to the multiplayer PD in what follows we shortly discuss in this section in which directions the dilemma can be solved.

A first obvious and simple solution is lowering as much as possible the extra cost (c) of the vote with the wallet. This is what occurs in two of the four examples we made in the introduction (SR investment funds if the universe of investable funds is large enough to eliminate the cost of missed diversification[19] and the Oxfam's *Behind the brand* campaign where in some of the proposed actions – such as sending a twit or a Facebook message to a company – there is no purchase and no extra economic and opportunity cost).

A second type of solution is a government intervention that may create room for lowering the extra cost in different ways (preferential access to public procurement according to the CSR stance of the bidders/characteristics of the product, ad hoc tax allowances such as green consumption taxes, etc.). If the government goal is the provision of some public goods it may find this kind of intervention optimal in order to foster the production of these public goods in the market by companies that internalize the externalities. Some of these directions are currently pursued by various institutions around the world[20].

A third type of solution relies on how, given c, individual consumers may try to solve the coordination problem. A standard approach applies the class of Folk theorems to the infinitely repeated game. Another interesting direction from this point of view is the de-

[19] The literature highlights that managers of SR investment funds voting with the wallet have three potential additional costs vis-à-vis managers of conventional investment funds (costs of acquiring information on the SR stance of investable stocks, missed diversification opportunities due to the application of their exclusion criteria and cost of disinvesting when a stock enters the exclusion list). Theoretical analysis however shows that the second cost becomes negligible or null as far as the universe of investable stocks is large enough (Herzel, Nicolosi and Starica, 2012). Empirical evidence confirms that risk adjusted returns of SR investment funds are not significantly different from those of conventional funds (Becchetti et al., 2014, and Varma and Nofsinger, 2012).

[20] The most relevant example is represented by feed-in tariff schemes for renewable energy adopted in 63 jurisdictions worldwide (Couture and Gagnon, 2010). In many countries dedicated outlets selling fairtrade products have a preferential fiscal treatment and green consumption taxes create fiscal advantages for more environmentally responsible value chains. These fiscal advantages can be directly on consumer prices or, when on producer prices, can be transmitted on consumers prices depending on demand/supply elasticities thereby reducing c in our model. In addition to it, governments directly vote with the wallet giving preferential treatment to SR products in procurement rules (i.e. Green Public Procurement rules are a relevant example, for their application in the EU see http://ec.europa.eu/environment/gpp/index_en.htm).

velopment of zero determinant (ZD) strategies. ZD strategies are memory one strategies (i.e. strategies in which player's behavior depends only from action in the previous period) unilaterally enforced by a single (focal) player who chooses as a strategy a linear reaction to other players' behavior. The literature in this respect documents that the action of the focal player is more important than what may be intuitively thought (Hilbe et al., 2014). The focal player adopting a ZD strategy can set a linear relationship between her payoff and the average of the payoff of her co-players. Stewart and Plotkin (2013) demonstrate that generous ZD strategies have strong power to make population evolve toward cooperation.

A fourth type of solution concerns the action of institutions that may organise coalitions of players that represent an important share of the market in order to enforce mutual cooperation (Hilbe et al., 2014).

In what follows we discuss these last two types of solutions (which are still less developed in the reality) by providing a contribution on how they can enforce mutual voting equilibria in the repeated game and give rise to new practical solutions of the multiplayer PD.

3 The repeated multiplayer game

Suppose now the multiplayer game is repeated for T stages. For any stage t ($t = 1, \dots, T$) we have n players. Each player i chooses an action $S^i \in \{V, A\}$ and obtains a payoff U_i. Now $G := (N, (S_i)_{i \in N}, (U_i)_{i \in N})$ represents each stage of the game.

We know from the Folk theorem[21] literature that we can overcome the prisoner's dilemma (i.e. we can solve the inefficiency of the NE) if and only if we play the game an infinite number of times since, by doing so, we can reach every feasible and enforceable payoff – and in particular mutual voting – as a NE outcome.

[21] See, among others, Fudenberg and Maskin (1986).

3.1 A Folk theorem for the vote with the wallet

Suppose each player adopts a grim strategy, that is, each player plays V as long as all her co-players do so and, if a deviation occurs, each player plays A forever. In the static game this strategy profile is not an equilibrium, since each player is better off by abstaining. However, when the game is repeated infinitely many times,[22] each player has to solve the trade-off between: i) getting the free riding payoff ($\frac{n-1}{n}b$) by abstaining and receiving 0 for the rest of the game, or ii) obtaining at each future stages the payoff $b + a - c$ discounted at each stage by δ. This problem can be written as

$$\frac{n-1}{n}b - (b + a - c) \leq (b + a - c) \sum_{t=1}^{+\infty} (1 - \delta)^t$$

and the discount rate (the level of patience) which ensures the mutual voting equilibrium is

$$\delta \leq \frac{n}{n-1}(1 - \frac{c-a}{b}) \tag{5}$$

We can define the $\frac{c-a}{b}$ factor in (5) as the *standardized voting with the wallet cost.* That is, the net cost of voting (extra cost from purchasing the responsible product minus the other regarding preference benefit) as a proportion of the voting benefit b. The inequality above tells us that a higher standardized voting with the wallet cost requires a higher level of players' patience to make the mutual voting equilibrium enforceable with a grim strategy in the infinitely repeated game. As well, a higher number of players requires a higher degree of patience. This is because, as n gets higher, the payoff players can obtain by abstaining also grows since the latter is represented by $(-\frac{1}{n}b - a + c)$. Note as well that in the PD area $\frac{n}{n-1}(1 - \frac{a-c}{b}) \in (0, 1)$, which ensures reasonable discount rates.

3.2 Evolutionary strategies and mutual voting

Evolutionary game theory, originally introduced in 1973 by Smith and Price to analyse the evolution of populations in biology, is nowadays applied by economists. While standard game theory assumes individuals behave rationally, evolutionary game theory allows for different individual behaviour such as the adoption of pre-determined strategies. Following Hilbe et al. (2014), our analysis will focus on different strategies that an individual, namely

[22] As is well known the assumption of an infinite number of game rounds is not necessarily unrealistic since it may simply imply that players do not know when the game ends and the discount rate may be assumed as being higher in proportion to the expectation of the proximity of the termination of the game.

focal player, can adopt to enforce mutual voting in the repeated vote with the wallet game.

First, we define a *memory-one strategy* adopted by player i as the $2n$-dimensional vector

$$\mathbf{p}^i := (p_{V,n-1}, \ldots, p_{V,0}, p_{A,n-1}, \ldots, p_{A,0})$$

where $p_{S^i,j} \in [0,1]$ denotes the probability to vote in the next stage provided that in the previous stage player i played the strategy $S^i \in \{V, A\}$ and j co-players voted.[23][24]

Then, we say that a *zero-determinant* (ZD) *strategy* is a memory-one strategy of the form

$$\mathbf{p} = \mathbf{p}^R + \phi((1-\sigma)(l\mathbf{1} - \mathbf{g}^i) + \mathbf{g}^i - \mathbf{g}^{-i}) \tag{6}$$

where $\mathbf{g}^i := (g^i_{S^i,j})$ and $\mathbf{g}^{-i} := (g^{-i}_{S^i,j})$ are the $2n$-dimensional vectors of possible payoffs for player i and average payoff of i's co-players respectively,[25] $\mathbf{1}$ denotes to the $2n$-dimensional vector of ones, ϕ is a payoff parameter inversely related to σ,[26] σ is the strategy slope, and l is the baseline payoff of the ZD strategy.[27] From Akin (2013),[28] we know that player i who applies a ZD strategy of of the form (6) can enforce the following payoff relation

$$G^{-i} = \sigma G^i + (1-\sigma)l \tag{7}$$

where G^i is the player i's payoff in the repeated game and G^{-i} is the average payoff of i's co-players in the repeated game.[29]

[23] More formally, a memory-one strategy should be defined together with an initial strategy. However, for our purpose the initial strategy does not matter for the final outcome, since the game is repeated infinitely many times and the strategy profile will definitely converge to a NE without regarding the initial strategy (Hilbe et al., 2014).

[24] Since the game is assumed to be symmetric (i.e. the payoff does not depend on who is the voting player, but on the number of voters only), memory-one strategies do not depend on the player i and accordingly we drop the index i for the sake of notation.

[25] Following Hilbe et al. (2014), in our game the average payoff of i's co-players is defined as $g^{-i}_{S^i,j} := \begin{cases} \frac{j(\frac{j+1}{n}b+a-c)+(n-j-1)(\frac{j+1}{n}b)}{n-1} & \text{if } S^i = V \\ \frac{j(\frac{j}{n}b+a-c)+(n-j-1)(\frac{j}{n}b)}{n-1} & \text{if } S^i = A \end{cases}$. Hence, the vectors $\mathbf{g}^i$ and $\mathbf{g}^i$ can be written as $\mathbf{g}^i = (\frac{1}{n}b + a - c, \frac{2}{n}b + a - c, \ldots, b + a - c, 0, \ldots, \frac{n-1}{n}b)$ and $\mathbf{g}^{-i} = (\frac{1}{n}b, \frac{1\cdot(\frac{2}{n}b+a-c)+(n-2)\frac{2}{n}b}{n-1}, \ldots, b + a - c, 0, \frac{1\cdot(\frac{1}{n}b+a-c)+(n-2)\frac{1}{n}b}{n-1}, \ldots, \frac{n-1}{n}b + a - c)$ respectively.

[26] More precisely, the relationship between the two parameters writes $\sigma = \frac{\alpha}{\phi}$ for any $\alpha \in \mathbb{R}$, and therefore we require $\phi \neq 0$.

[27] Note that we will set $l = b + a - c$, since we will look at those strategies that allow for mutual voting.

[28] In particular, following the notation in Hilbe (2014), we apply Akin (2013) [Theorem 1.3] to our voting with the wallet game.

[29] Hilbe et al. (2014) defines the *player i's payoff in the repeated game* as $G^i := \lim_{T\to\infty} \sum_{t=1}^{T} U_i(t)$, where $U_i(t)$ is the player i' payoff at stage t, and the *average payoff of i's coplayers in the repeated game*

Thus, strategy slope σ captures the variation of the co-players' average payoff G^{-i} as the player i's payoff G^i varies, and the baseline payoff is the payoff obtained by each player when playing the same strategy. When $\sigma < 1$ we say that the strategy is *generous*, and when $\sigma = 1$ we say that the strategy is *fair* (Hilbe et al., 2014).

In what follows we show how the PD can be overcome with two strategy examples: a pure memory-one Pavlov strategy, and the ZD proportional Tit-for-tat (pTFT) strategy .

3.2.1 The Pavlov strategy

The *Pavlov strategy* is a memory-one strategy that can be represented by the vector

$$\mathbf{p}_{Pav} = (1, 0, \ldots, 0, 1),$$

that is, the focal player who applies a Pavlov strategy will vote after mutual voting or after mutual abstention only. The intuition is that players will continue to vote whether all the other players vote, and they will as well vote after all players abstained in the previous stage giving a new opportunity for a mutual voting equilibrium. The Pavlov strategy therefore differs from the grim strategy defined in section 3.1 for this new opportunity of cooperation given in spite of other players defection in the previous round.

By applying Hilbe et al. (2014) necessary and sufficient conditions for a memory-one strategy to be a NE, we have for our voting with the wallet game that

Proposition 3.1 (Pavlov strategy conditions allowing for mutual voting)**.** *Mutual voting with the Pavlov strategy is a NE if and only if*

$$\begin{aligned} 0 < n \leq \frac{b}{2(c-a)-b} \quad & \textit{for} \quad c \geq a + \frac{b}{2} \\ n > 0 \quad & \textit{for} \quad c < a + \frac{b}{2} \end{aligned}$$

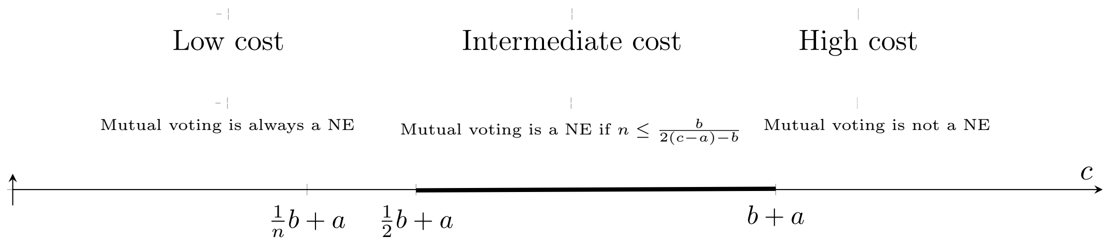
Proof. See appendix A. □

Proposition 3.1 tells that mutual voting with the Pavlov strategy is always a NE if the cost is sufficiently small (Figure 3). When the cost is too low ($c < \frac{1}{n}b + a - c$), this is not surprising, since mutual voting was already an (efficient) NE. Then, what the Pavlov

as $G^{-i} := \sum_{k=1}^{n} \frac{1}{n-1} G^k$. It can be easily shown that we have $G^i = \mathbf{g}^i \cdot \mathbf{v}$ and $G^{-i} = \mathbf{g}^{-i} \cdot \mathbf{v}$, where $\mathbf{v} := \lim_{t\to\infty} \mathbf{v}(t)$ is the limit point of the $2n$-dimensional vector $\mathbf{v}(t) := (v_{S^i,j}(t))$ and $v_{S^i,j}(t)$ denotes the probability that at stage t the focal player i plays $S^i \in \{V, A\}$ and j of the i's co-players vote.

strategy solves vis-à-vis the standard multiplayer game described in section 2.1, is the PD for $\frac{1}{n}b + a < c < \frac{1}{2}b + a - c$, that is, the case when the cost of voting is the lowest within the intermediate area of PD 2. However, at the right side of the segment where the cost (c) is too high, the Pavlov strategy is unable to prevent mutual abstention from being a NE.[30]

Figure 3: The three regions of equilibria along the segment of c values in the multiplayer game where players adopt a Pavlov strategy.



3.2.2 The proportional tit-for-tat strategy

In order to apply the proportional tit-for-tat strategy we need to make explicit some properties that characterize the ZD strategies allowing for stable cooperation to be a NE of the voting with the wallet game.

Proposition 3.2. *Consider the voting with the wallet game described above. If the focal player sets the baseline payoff $l = b + a - c$ and applies a ZD strategy with parameter*

$$\sigma \geq \frac{n-2}{n-1} \tag{8}$$

then mutual voting is a NE.

Proof. See appendix A □

Proposition 3.2 links the power of the focal player to enforce a linear relationship between her payoff and the average payoff of the other players and the Nash equilibrium of the game. The condition on l tells us that the baseline payoff must be the maximum payoff $b+a-c$. Intuitively, we want that the group payoff is maximized and equal to $b+a-c$ when all players play the same strategy. The condition on σ concerns the fairness of the focal player, because it requires the slope to be very close (but not equal) to one. This means that the focal player should adopt a strategy that gives a slightly higher average payoff

[30] Note that in Proposition 3.1 the number of players n is a natural number, so that in the high differential cost we cannot have n smaller than 1 and therefore mutual voting is not a NE.

to the co-players. We remember from section 3.2 that a slope equal to one corresponds to a fair strategy. Then, the focal player strategy from Proposition 3.2 can be considered generous, but not too generous. Another implication of this proposition is that the focal player will increase its generosity as far as the number of players is low (σ is decreasing in n), while generosity is "inefficient" in terms of bringing other players toward the voting strategy when the number of players is too high.

The proportional tit-for-tat strategy is an example of ZD strategy which can be viewed as a generalized version of the tit-for-tat strategy. When the proportional tit-for-tat is played, the probability to vote is given by the proportion of voters among the co-players in the previous round. More formally, the *proportional tit-for-tat* (pTFT) strategy is a mixed strategy and it can be represented by

$$p_{pTFT} = (0, \frac{1}{n-1}, \frac{2}{n-1}, \ldots, 1, 0, \frac{1}{n-1}, \frac{2}{n-1}, \ldots, 0),$$

and the probability to cooperate at stage $t = 1$ is equal to one. When the number of players is equal to 2, it becomes the standard TFT strategy used in section 3.1 for the Folk theorem.

The pTFT strategy is a ZD strategy.[31] In particular, it is a fair strategy. Therefore, from Proposition 3.2 we have that the pTFT is a NE for the voting with the wallet game.

4 The power of coordination

The applications of the Folk theorem in the multiperiod game where players adopt grim strategies and of the Pavlov and proportional tit-for-tat strategies in evolutionary games enacted by individual players significantly restrict the area of the PD but in real world circumstances they may fail in two directions: i) Folk theorems are difficult to enforce in presence of a large number of players and non infinite number of rounds due to the well-known endgame problems; ii) the time needed to reach the mutual voting equilibrium in evolutionary games may be too high; iii) individuals may have higher power in enforcing the mutual voting equilibrium if they act in coalitions, such as labor associations, labor

[31] In Appendix A we show that it can be obtained by equation (6) setting $\sigma = 1$ and $\phi = \frac{1}{c-a}$.

unions, or political parties.

Coalitions are particularly useful since we have seen that the power of strategies enacted by individual players to enforce mutual voting is much weaker as far as the number of players grows (section 2.1).

Suppose a coalition is composed by k_{Coal} members, $1 \leq k_{Coal} < n$, who are able to set a strategy $\mathbf{p}$ they will play during the game. By applying (Hilbe et al., 2014) results on strategy alliances, we find a coalition composed by k_{Coal} members can enforce mutual voting if and only if either the coalition adopts a fair strategy, or a generous strategy and[32]

$$k_{Coal} \geq \frac{n}{2}(1 - \frac{c-a}{b(1-\sigma)}) \tag{9}$$

We have shown in proposition 3.2 that individuals cannot enforce mutual voting by adopting too generous strategies. On the other hand, (9) shows that the higher is the coalition size (high k_{Coal}), the more the strategy can be generous (low σ)[33].

4.1 The *coalition of the willing* and the paradox of altruism

A more intuitive example illustrating how a coalition can work is provided above.

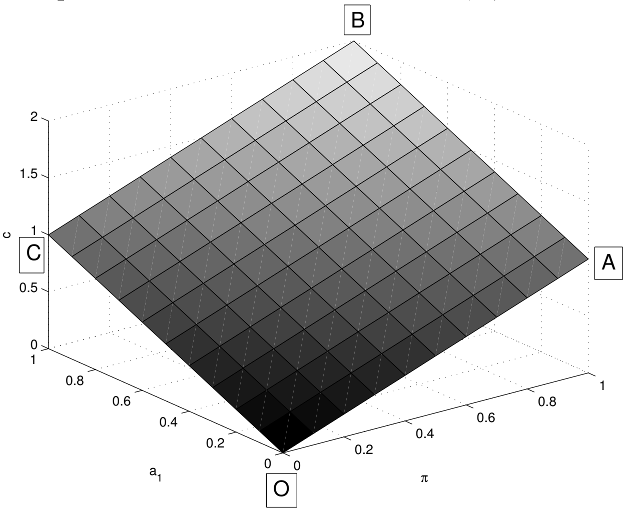
Suppose the existence of a share π^* of non income constrained individuals with other-regarding preferences of the form a^* where $a^* > c - \pi^* b$ or $\pi^* > \frac{c-a^*}{b}$. These individuals would nonetheless vote with the wallet if they could coordinate and form a *coalition of the willing* which synchronizes their voting choices. Based on the above inequality, $\pi_{min} = \frac{c-a^*}{b}$ can be defined as the minimum threshold voting with the wallet coalition required by individuals with other regarding preferences higher of equal to a^* to vote with the wallet.

Figure 4 shows the three-dimensional (π, a^*, c) threshold of feasible parameter values for a "coalition of the willing" when conveniently normalizing $b = 1$. The plane $c = 0$ always belongs to our set because it corresponds to the situation in which the cost of voting is null, and therefore the benefit for each individual of the coalition satisfies $b + a^* \geq b$ for all a^*. Hence, when $c = 0, \pi_{min} = 0$. However, when c rises, the other-regarding preference

[32] Proof in Appendix A.

[33] As we have seen above, one example of ZD strategy a coalition can apply is the proportional TFT.

Figure 4: The plane of admissible values for a^*, c, and π where $b = 1$.



coefficient a^* also has to rise in order to keep $\pi_{min} = 0$ (segment $\overline{OC}$). The interpretation is that, the higher is the cost of voting, the higher must be the other regarding preferences of individuals to ensure compatibility with the lowest coalition threshold. On the other hand, the coalition of the willing must be larger in presence of a higher cost c in order to convince individuals with other regarding preferences to vote.[34]

Suppose now that an organization can form a coalition of the willing so that a share $\pi^* > \pi_{min}$[35] of altruists reveal their strategy $p_{t_1} = (1, 1, 1, 1)$ at t_1 (the coalition of the willing vote a time t_1, no matters the previous outcome at t_0).

The strategy can be revealed for example through a cash mob[36] where the coalition plays the voting with the wallet strategy and announces her strategy for the future. After the strategy is revealed the remaining players will however abstain if $c < (1 - \pi)b + a^*$ or

[34] As an extreme case, when the cost is too high and other regarding preferences are too small, $\pi_{min} = 1$, implying that there will always be (at least one) individual for whom abstaining is the best strategy (segment $\overline{AB}$). Note as well that when all players are willing to vote and every individual has a preference to vote equal to the benefit of the public good component (the numeraire b), then the extra cost can be up to twice as much the numeraire b (point B).

[35] This is a necessary condition to make the voting with the wallet strategy nonetheless incentive compatible.

[36] The cash mob is a media (video recorded) event where an organised group of sellers goes into a retail outlet to buy a given product and intend to communicate its decision to the general public. For a reference to the US cash mob experience see http://cash-mobs.com/

because they will fall into the prisoner's dilemma if

$$\frac{1}{n}b + a^* < c < (1 - \pi)b + a^*$$

Assuming that the above inequality holds, in order to avoid the prisoner's dilemma the coalition of the willing announces that their strategy at t_1 will be $p_{t_1} = (1, 0, 1, 0)$ which consists in punishing the free riders at period t_1 by not voting with the wallet.

Given the coalition of the willing's strategy, the benefit in t_1 for the myopic self-interested individuals who abstain is

$$\pi^* b - (b + a^* - c) = c - a^* - (1 - \pi^*)b$$

The potential loss for out-of-coalition individuals from the punishment occurring when members of the coalition of the willing deviate from their voting strategy, is

$$\frac{\pi^* b}{1 + \delta}$$

where δ is the discount rate measuring players' patience.

The potential abstainers will vote if punishment is higher than temptation, that is

$$\frac{\pi^* b}{1 + \delta} - (c - a^* - b(1 - \pi^*)) > 0 \tag{10}$$

or

$$\pi^* < (\frac{1 + \delta}{\delta})(\frac{c - a^*}{b} - 1) \tag{11}$$

Inequality (7) outlines an altruism paradox since, coeteris paribus, in a (two period) finite number of rounds a larger coalition (generated by a higher number of individuals with high enough other-regarding preferences) increases and does not reduce the propensity to free ride given the specific characteristics of the vote with the wallet game. This is because, as it is clear from the inequality (11), with a higher π, the marginal benefit of free riding will be higher than the marginal cost.

In order to analyse the effect of a coalition on the patience of players, we elaborate a Folk theorem in presence of a coalition action. Suppose now a coalition of k voters will vote at each stage without taking into account the other players' strategies. In other words, we are now assuming a coalition of players who decide to vote even if the other players abstain. Then each voter has to solve the problem

$$\begin{aligned} \frac{n-1}{n}b + \frac{k}{n}b\sum_{t=0}^{+\infty}(1-\delta)^t - (b+a-c) &\leq (b+a-c)\sum_{t=0}^{+\infty}(1-\delta)^t \\ \text{or } \delta &\leq \frac{((1-\frac{k}{n}) - \frac{c-a}{b})n}{(1-\frac{k}{n})n-1} \end{aligned}$$

Hence, within the PD area, when the paradox of altruism holds the patience parameter δ is higher than the previous patience parameter measured in the absence of coalition.[37]

4.2 Renegotiation proofness

We wonder whether the strategies used to enforce the mutual voting equilibrium described above are renegotiation proof. The cost of punishing for the punisher (that is, what she loses by executing the punishment) is $b-a-c$ if the alternative is full coordination, or π^*b-a-c if the alternative is partial coordination. Hence the strategy is renegotiation proof if we reasonably assume that there is no way to enforce free riders to play cooperatively in time $t+1$ after they free-rided at time t and if $c > \pi^*b + a$. Under such condition the tit-for-tat strategy announced by the coalition of the willing is renegotiation proof, that is, there is no interest for the punishers to renegotiate the strategy after the violation of the free riders and before the punishment for that violation is enacted.

4.3 The optimal cash mob

Based on what observed above about the power of coalitions and the paradox of altruism in the voting with the wallet game we outline the characteristics of a bottom-up mechanism design which can bring to the mutual voting equilibrium in the infinitely repeated game.

A coalition of the willing may reveal its existence and strategy by organizing a cash mob which must include the following features

[37] The altruism paradox does not imply that cash mobs and coalitions are not useful since, when other regarding preferences of coalition members are not high enough, they produce the effect of triggering the vote with the wallet of coalition members (who would have abstained if playing the game in isolation).

1. Declaration of the number k of coalition members;

2. Communication to the general public of the crucial parameters of the game and, more specifically b, c and n;

3. Communication of the "permanent" commitment of coalition members to play the voting strategy (to avoid the paradox of altruism documented in section 4.1) by subscription a pre-authorized debit (PAD) for the purchase of the SR product which is automatically renewed in absence of a cancelation notice;

4. Definition of the “threat”: that is, the commitment of coalition members to abstain from voting if other players in the game do not subscribe. As shown above in section 4.2 the threat is renegotiation proof as far as we are in the PD segment since $c > \frac{1}{n}b + a$.

The cash mob plays the role of a reinforced signal. It is more effective than a press conference because the public announcement is accompanied by a credible commitment to enact the strategy. Its success depends on the rationality of the non-coalition players and on their agreement on the model parameters (the benefit b and the cost c), which is ensured ex ante by assumption in the theoretical model while it is not in reality. [38]

5 Conclusion

Consumers' willingness to pay and revealed preferences implicit in the non negligible market shares of socially responsible consumption and savings document that the *vote with the wallet* is becoming an increasingly relevant feature of contemporary economics. Growth of fair trade products and socially responsible investment funds document that non-price demand elasticity (where consumers consider CSR as one of the product characteristics on which they base their choices) matters.

Our paper deals with these novel features of contemporary markets by focusing on the demand side characteristics of the vote with the wallet game and its embedded multiplayer

[38] As said in the introduction, the perception of b is easier in some specific dimensions of corporate responsibility. For instance, a rise in corporate fiscal responsibility should produce a clearly identifiable increase in domestic fiscal revenues and therefore in resources available for local public goods.

prisoner's dilemma generated by the public good characteristics of the benefits produced by the vote.

The vote with the wallet game described in this paper postulates that solutions to the dilemma depend on four fundamental parameters: the nonrivalrous and non excludable positive effect on consumers induced by the corporate move toward CSR stimulated by the vote with the wallet, the players' other-regarding preference parameter, the extra purchasing cost generated by the vote with the wallet and the share of individuals who vote with the wallet which acts as a weight for the benefit produced by the first factor having public good components.

Since the vote with the wallet game is actually played by millions of consumers we study some coordinated solutions to its prisoner's dilemma.

First of all, we document that the area of the dilemma widens as far as the number of players grows as it is typically the case in global consumer markets. We as well outline conditions under which the PD inefficiency can be overcome with Folk theorems in presence of grim strategies showing that the two crucial parameters affecting threshold level of patience are the number of players and the standardized cost of voting, that is, the net cost of voting (extra cost minus the other regarding preference benefit) as a proportion of the voting benefit b. We then investigate how Pavlov and proportional tit-for-tat strategies in evolutionary games enacted by individual players may lead to the mutual voting equilibrium.

We finally show that the formation of stable coalitions of voting players may lead to a larger positive externality generated by more corporate social responsibility but fall into the paradox of altruism by increasing the other players' propensity to free ride.

Results and their discussion in the paper allow to compare the theoretical mechanism designs devised in the paper with real life experiences in the voting with the wallet game (such as cash mobs and the behavior of sustainable purchasing groups) indicating some directions which may help to strengthen the capacity of the latter to enforce a mutual voting equilibrium. In this respect we observe that many of the voting with the wallet experiences in action described in our discussion section work on the two sides (reducing the extra cost c and enhancing the cooperation of voters) which can reduce the PD inefficiency, and can get stimulating insights from results and considerations developed in the paper.

A Appendix

Proof of equation (4). We look for the pure NE of the multiplayer vote with the wallet game represented in extensive form by figure A. First, we show that mutual abstention is a pure NE if and only if $\frac{1}{n}b + a < c$. Let $J = \{1, \ldots, i-1, i+1, \ldots, n\}$ and assume that each player $j \in J$ votes. Then player i prefers $\frac{n-1}{n}b$ to $b + a - c$ if and only if $\frac{1}{n}b + a < c$. Now, suppose that $n-1$ players in J vote, and the remaining individual abstain. Then, player i prefers $\frac{n-2}{n}b$ to $\frac{n-1}{b} + a - c$ if and only if $\frac{1}{n}b + a < c$. Recursively, suppose $n-k$ players in J vote, and the remaining k abstain, for each $k = 1, \ldots, n-1$. Then, player i prefers $\frac{n-k-1}{n}b$ to $\frac{n-k}{b} + a - c$ if and only if $\frac{1}{n}b + a < c$. Hence, since player i is chosen arbitrarily, we can conclude that mutual abstention is a pure NE if and only if $\frac{1}{n}b + a < c$. Analogously, we can show that mutual voting is a NE if and only if $\frac{1}{n}b + a \geq c$. Suppose each player $j \in J$ abstains. Then player i prefers $\frac{1}{n}b + a - c$ to 0 if and only if $\frac{1}{n}b + a > c$. Now, suppose $n-1$ players in J abstain, and the remaining individual vote. Then, player i prefers $\frac{2}{n}b + a - c$ to $\frac{1}{n}b$ if and only if $\frac{1}{n}b + a > c$. Recursively, suppose $n-k$ players in J abstain, and the remaining k vote, for each $k = 1, \ldots, n-1$. Then, player i prefers $\frac{k+1}{n}b + a - c$ to $\frac{k}{n}b$ if and only if $\frac{1}{n}b + a > c$. Hence, since player i is chosen arbitrarily, we can conclude that mutual voting is a pure NE if and only if $\frac{1}{n}b + a > c$. □

Proof of Proposition 3.1. Hilbe et al. (2014) [Supporting Information, Proposition 4] characterizes all pure memory-one strategy that allows for mutual cooperation in a social dilemma. Hence, for the vote with the wallet game a pure memory-one strategy allowing for mutual cooperation must satisfy the following conditions: (i) $p_{V,n-1} = 1$, (ii) $p_{V,n-2} = 0$, (iii) $p_{A,1} \leq \frac{b+a-c-\frac{1}{n}b}{\frac{n-1}{n}b-(b+a-c)}$, (iv) $p_{A,0} \leq \frac{b+a-c}{\frac{n-1}{n}b-(b+a-c)}$. For the Pavlov strategy, conditions (i) and (ii) always hold, and condition (iii) holds if and only condition (**??**) holds. Indeed, (4) implies $0 \leq \frac{b+a-c-\frac{1}{n}}{\frac{n-1}{n}b-(b+a-c)}$ since $b + a - c - \frac{1}{n} \geq 0$ and $\frac{n-1}{n}b - (b + a - c) \geq 0$. Lastly, for condition (iv) we have

$$
\begin{aligned}
p_{A,0} = 1 \leq \frac{b+a-c}{\frac{n-1}{n}b - (b+a-c)} \quad &\iff \quad \frac{n-1}{n}b - (b+a-c) \leq b+a-c \\
&\iff \quad -b - 2(a-c) \leq \frac{1}{n}b \\
&\iff \quad n(-1 - \frac{2(a-c)}{b}) \leq 1 \\
&\iff \quad \begin{cases} n \leq \frac{b}{2(c-a)-b} \text{ if } -1 - \frac{2(a-c)}{b} \geq 0 \\ n > \frac{b}{2(c-a)-b} \text{ if } -1 - \frac{2(a-c)}{b} < 0 \end{cases} \\
&\iff \quad \begin{cases} n \leq \frac{b}{2(c-a)-b} \text{ if } c \geq \frac{b}{2} + a \\ n > \frac{b}{2(c-a)-b} \text{ if } c < \frac{b}{2} + a \end{cases},
\end{aligned}
$$

and since n is a natural number and $\frac{b}{2(c-a)-b} < 0$ if $c < \frac{b}{2} + a$, then we have that

$$\begin{cases} n \leq \frac{b}{2(c-a)-b} \text{ if } c \geq \frac{b}{2} + a \\ n > 0 \text{ if } c < \frac{b}{2} + a \end{cases}.$$

□

Proof. (pTFT is a ZD strategy). From equation (6), setting $\phi = c - a$ and $\sigma = 1$, we have $\mathbf{p} = \mathbf{p}^R + \frac{1}{c-a}(\mathbf{g}^i - \mathbf{g}^{-i})$ writes

$$\begin{aligned} \mathbf{p}_{TFT} &= \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \\ 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix} + \frac{1}{c-a}\left(\begin{pmatrix} \frac{1}{n}b + a - c \\ \frac{2}{n}b + a - c \\ \vdots \\ b + a - c \\ 0 \\ \frac{1}{n}b \\ \vdots \\ \frac{n-1}{n}b \end{pmatrix} - \begin{pmatrix} \frac{1}{n}b \\ \frac{\frac{2}{n}b + a - c + (n-2)\frac{2}{n}b}{n-1} \\ \vdots \\ b + a - c \\ 0 \\ \frac{\frac{1}{n}b + a - c + (n-2)\frac{1}{n}b}{n-1} \\ \vdots \\ \frac{n-1}{n}b + a - c \end{pmatrix} \right) \\ &= \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \\ 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix} + \frac{1}{c-a} \cdot \begin{pmatrix} a - c \\ \frac{a-c}{n-1} \\ \vdots \\ 0 \\ \frac{c-a}{n-1} \\ \vdots \\ c - a \end{pmatrix} = \begin{pmatrix} 0 \\ \frac{1}{n-1} \\ \vdots \\ 1 \\ 0 \\ \frac{1}{n-1} \\ \vdots \\ 1 \end{pmatrix} \end{aligned}$$

□

Proof of Proposition 3.2. We apply Hilbe et al. (2014), [Supporting information, Proposition 3] to our game, and we assume $\sigma \geq \frac{n-2}{n-1}$ and $l = b + a - c$. By contradiction, we also assume that the ZD strategy (l, σ) is not a Nash equilibrium. Then there exists (at least) a player i' who strictly prefer to deviate from voting, and who obtain a payoff $G^{i'} > b + a - c$. By equation (7), we have that the (at most) $n - 2$ players adopting the ZD strategy can enforce the relation $\frac{n-2}{n-1}G^i + \frac{1}{n-1}G^{i'} = \sigma G^i + (1 - \sigma)(a + b - c)$, that is $G^{i'} = \tilde{\sigma}G^i + (1-\tilde{\sigma})(b+a-c) = (b+a-c) + \tilde{\sigma}(G^i - (b+a-c))$ where $\tilde{\sigma} := (n-1)\sigma - (n-2) > 0$ by assumption. Hence, we have that $G^{-i'} > b + a - c$, that is the average payoff of all individuals is greater that $b + a - c$, and this contradicts the assumption that $b + a - c$ is the maximum outcome. □

Proof of Equation 9. From Hilbe et al. (2014) [Supporting information, Proposition 6], we know that a strategy alliance can enforce the payoff relation (l, σ) if and only if either

$\sigma = 1$ or

$\sigma < 1$ and

$$\max_{0 \le j \le n-k_{Coal}} \{\frac{j}{n}b - \frac{j}{n-k_{Coal}} \frac{\frac{j}{n}b - (\frac{j}{n}b + a - c)}{1-\sigma}\} \le$$

$$\le \quad l \le \min_{k_{Coal}-1 \le j \le n-1} \{\frac{j+1}{n}b + a - c + \frac{n-j-1}{n-k_{Coal}} \frac{\frac{j+1}{n}b - \frac{j+1}{n}b + a - c}{1-\sigma}\}.$$

The last condition applied to out game writes

$$\sigma < 1 \text{ and} \tag{12}$$

$$\max_{0 \le j \le n-k_{Coal}} \{\frac{j}{n}b - \frac{j}{n-k_{Coal}} \frac{c-a}{1-\sigma}\} \le \tag{13}$$

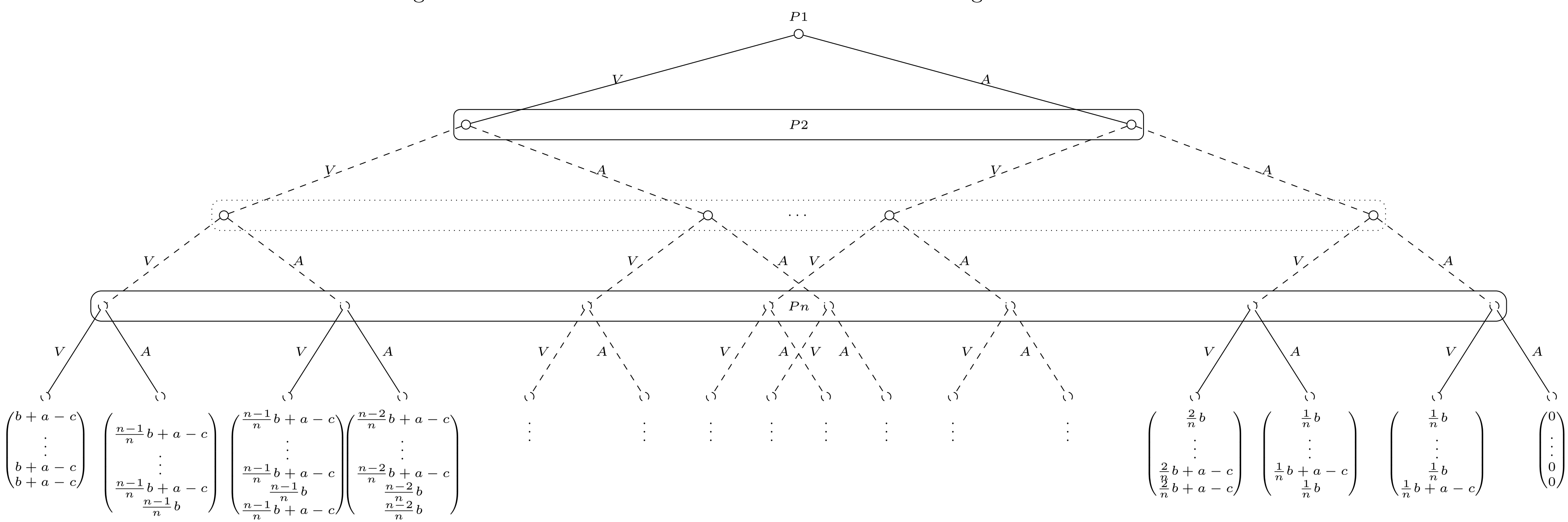
$$\le \quad l \le \min_{k_{Coal}-1 \le j \le n-1} \{\frac{j+1}{n}b + a - c + \frac{n-j-1}{n-k_{Coal}} \frac{c-a}{1-\sigma}\}. \tag{14}$$

Hence, for enforcing mutual cooperation, we want that $\min_{k_{Coal}-1 \le j \le n-1}\{\frac{j+1}{n}b + a - c + \frac{n-j-1}{n-k_{Coal}} \frac{c-a}{1-\sigma}\} = b + a - c$, and this equality holds if and only if

$$\begin{aligned}
\frac{1}{n}b - \frac{1}{n-k_{Coal}} \frac{c-a}{1-\sigma} &\le 0 \iff \\
\frac{1}{n}b &\le \frac{1}{n-k_{Coal}} \frac{c-a}{1-\sigma} \iff \\
(n-k_{Coal}) &\le n\frac{c-a}{(1-\sigma)b} \iff \\
k_{Coal} &\ge n(1 - \frac{c-a}{(1-\sigma)b})
\end{aligned}$$

where we used the fact that $b, n > 0$. □

Figure 5: The extensive form of the vote with the wallet game.



References

[1] Akin, E. (2013), "Stable cooperative solutions for the iterated prisoner's dilemma", arXiv:1211.0969 [math.DS] (or arXiv:1211.0969v2 [math.DS] for this version).

[2] Andreoni, J. (1989), "Giving with impure altruism: applications to charity and ricardian equivalence", *Journal of Political Economy*, University of Chicago Press, 97(6), 1447-58.

[3] Andreoni, J. (1990), "Impure altruism and donations to public goods: a theory of warm-glow giving?", *Economic Journal, Royal Economic Society*, 100(401), 464-77.

[4] Andreoni, J., and J. Miller (2002), "Giving according to GARP: an experimental test of the rationality of altruism", *Econometrica*, 70(2), 737-753.

[5] Arce, D.G., and T. Sandler (2005), "The dilemma of the prisoners' dilemma", *Kyklos*, Wiley Blackwell, 58(1),3-24.

[6] Arora S., and S. Gangopadhyay (1995), "Toward a theoretical model of voluntary overcompliance", *Journal of Economic Behavior & Organization*, 28(3), 289-309.

[7] Bagnoli, M. and S.G. Watts (2003), "Selling to socially responsible consumers: competition and the private provision of public goods", *Journal of Economics & Management Strategy*, 12(3), 419-445.

[8] Baron, D.P. (2002), 'Private politics and private policy: a theory of boycotts", *Standford GSB Research Paper Series*, 1766.

[9] Becchetti L., and N. Solferino (2011), "What to do in globalised economies if global governance is missing? The vicarious role of competition in social responsibility", *International Review of Economics*, 58(2), 185-211.

[10] Becchetti, L., R. Ciciretti, A. Dalo, and S. Herzel (2014), "Socially responsible and conventional investment funds: performance comparison and the global financial crisis", *Working Paper Series*, 04_14, The Rimini Centre for Economic Analysis.

[11] Ben-Ner, A. and L. Putterman (2010), "Trusting, trustworthiness, and CSR: some experiments and implications", in: Sacconi, L., M. Blair, R.E. Freeman, and A. Vercelli

(eds.), “Corporate social responsibility and corporate governance: the contribution of Economic theory and related disciplines”, *Palgrave Macmillan*, Basingstoke, International Economic Association, 149, 381-409.

[12] Berg J., J. Dickhaut, and K. McCabe (1995), “Trust, reciprocity and social history”, *Games and Economic Behaviour*, 10, 122-142.

[13] Besley, T., and M. Ghatak (2007), “Retailing public goods: the Economics of corporate social responsibility", *Journal of Public Economics*, 91(9), 1645-1663.

[14] Bolton, G.E., and A. Ockenfels (2000), “A theory of equity, reciprocity and competition”, *American Economic Review*, 90(1), 166-93.

[15] Camerer, C. F. and R.H. Thaler (1995), “Ultimatums, dictators and manners”, *Journal of Economic Perspectives*, 9, 209-19.

[16] Carson, R.T., N.E. Flores, and N.F. Meade (2001), “Contingent valuation: controversies and evidence", *Environmental And Resource Economics*, 19, 173-210.

[17] Charness, G., and M. Rabin (2002), “Understanding social preferences with simple tests”, *The Quarterly Journal of Economics*, MIT Press, 117(3), 817-869.

[18] Cox, C.J. (2004), “How to identify trust and reciprocity”, *Games and Economic Behavior*, 46, 260-281.

[19] Engel, C. (2010), “Dictator games: a meta study”, *MPI Collective Goods Preprint*, 2010/07.

[20] EU Commission (2009), “Contributing to sustainable development: the role of fair trade and non-governmental trade-related sustainability assurance schemes”, Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee.

[21] Fehr, E., G. Kirchsteiger, and A. Riedl (1993), “Does fairness prevent market clearing? An experimental investigation”, *Quarterly Journal of Economics*, 108, 437-459.

[22] Fehr, E., E. Kirchler, A. Weichbold, and S. Gächter (1998), "When social forces overpower competition: gift exchange in experimental labor markets", *Journal of Labor Economics*, 16, 324-351.

[23] Fehr E. and K.M. Schmidt (1999), "A theory of fairness, competition and cooperation", *The Quarterly Journal of Economics*, 114, 817-868.

[24] Fehr, E. and S. Gächter (2000), "Cooperation and punishment in public goods experiments", *American Economic Review*, 90, 980-994.

[25] Fischbacher, U., S. Gächter, and E. Fehr (2001), "Are people conditionally cooperative? Evidence from a public goods experiment", *Economics Letters*, 71, 397-404.

[26] Fudenberg, D., and E. Maski (1986), 'The Folk theorem in repeated games with discounting or with incomplete information", *Econometrica*, 54(3), 533-554.

[27] Güth, W., R. Schmittberger, and B. Schwarze (1982), "An experimental analysis of ultimatum bargaining", *Journal of Economic Behavior and Organization*, III, 367-88.

[28] Hayes, M. (2004), "Strategic management implication of the ethical consumer", http://researchfairtrade.com

[29] Herzel, S., M. Nicolosi, and C. Starica (2012), "The cost of sustainability in optimal portfolio decisions", *European Journal of Finance*, 18(3-4), 333-349.

[30] Hilbe C., B. Wu, A. Traulsen, and M.A. Nowak (2014), "Cooperation and control in multiplayer social dilemmas", *PNAS*, 111, 16425-16430.

[31] Labadi, S., Long, C., (2010),Heritage and Globalisation. Routledge.

[32] LeClair, M.S. (2002), "Fighting the tide: alternative trade organizations in the era of global free trade", *World Development*, 30(7), 1099-1122.

[33] Maynard Smith, J. and Price, G.R. (1973), "The logic of animal conflict", *Nature*, 246(5427), 15-18.

[34] Maseland, R. and A. de Vaal (2002), "How fair is fair trade?", *De Economist*, 150(3), 251-72.

[35] Moore, G. (2004), "The fair trade movement: parameters, issues and future research", *Journal of Business Ethics*, 53(1-2), 73-86.

[36] Nielsen Global Consumer Confidence Report (2012), downloadable at `http://www.nielsen.com/us/en/reports.html`

[37] Rabin, M. (1993), "Ìncorporating fairness into Game theory and Economics", *American Economic Review*, 83(5), 1281-1302.

[38] Redfern, A., and P. Snedker (2002), "Creating market opportunities for small enterprises: experiences of the fair trade movement", *ILO*, Geneva.

[39] Sonnemans, J., A. Schram, and T. Offerman (1999), "Strategic behavior in public good games – when partners drift apart", *Economics Letters*, 62, 35-41.

[40] Starr F., (2013), Corporate Responsibility for Cultural Heritage: Conservation, Sustainable Development, and Corporate Reputation (Vol. 4), Routledge.

[41] Varma, A. and Nofsinger, J.R., "Socially responsible funds and market crises" (September 6, 2012), *Journal of Banking and Finance*, Forthcoming. Available at SSRN: http://ssrn.com/abstract=2142343 or http://dx.doi.org/10.2139/ssrn.2142343