Two to Tango: Trust, Taxation and the Economics of Environmental Policy

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PhD in Economics | Stefano Carattini

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Abstract

This thesis examines the question of environmental dilemmas from both a local and a global perspective. It explores the open question of cooperation in the climate commons and provides evidence in favor of a key role of trust in spurring cooperation in global dilemmas. Given the potential for cooperation in both local and global environmental dilemmas, this thesis explores the rationales for the limited diffusion of environmental taxes. It encompasses the issues of effectiveness and public acceptability in local and global situations and concludes that what most likely hampers the implementation of environmental taxes is the general public's perception of ineffectiveness rather than any empirical ineffectiveness. Finally, it provides new insights on how to overcome this barrier to effective policymaking tackling local and global externalities.

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Preface

Why do not we pay for carbon emissions? In spite of the general consensus within the scientific community and across most policymakers on the urgency of addressing climate change's threat, the current efforts for climate change mitigation are largely insufficient (cf. UNEP 2013; IPCC 2014). However, the economic prescriptions for addressing environmental externalities are relatively clear (see Hahn 1989). In such situation, economic theory would suggest to correct the externality generated by greenhouse gas emissions with e.g. environmental taxes. Most economists consider indeed environmental taxes as a tool to reduce pollution in the least expensive way, even though they may disagree, for practical or theoretical reasons, on the possibility to reach an "optimal" level of pollution. Given that the bulk of greenhouse gas emissions consists in carbon emissions, this environmental tax could take the form of a carbon tax. Looking at worldwide data on carbon pricing, however, we see that the club of countries having implemented carbon taxes is rather small, although in recent years new members joined the forerunners of the 90's (Baranzini and Carattini 2014; World Bank 2014).

Standard economic theory could again provide an explanation for this lack of engagement towards climate change mitigation. Since the benefits of climate change mitigation are global (and future, and uncertain) and the costs are local (and immediate), no single country is expected to be willing to bear the cost of climate change mitigation. That is, from a standard perspective, climate change mitigation can be represented by the notorious prisoner's dilemma common to all commons (cf. Olson 1965; Hardin 1968). However, not all commons necessarily turn into tragedies. Provided that trust is established among stakeholders, the dominating strategy can switch from predatory to cooperative behavior. As shown by Ostrom (1990) with respect to local dilemmas, the pessimistic prediction of standard economic theory does not always have to hold.

But what about global dilemmas: is there any cooperation in the climate commons? According to Ostrom (2009), there is much more cooperation in the climate commons

than what standard economic theory presumes (see also Tavoni and Levin 2014), even though its level is currently clearly insufficient to cope with the challenge of climate change. Ostrom (2009) reviews a panoply of grassroots initiatives aiming at reducing greenhouse gas emissions at the local level and, as she did with the local commons, calls for a paradigm shift in the way economists look at climate change mitigation. As already predicted by Sen (1977), individuals may be more sophisticated than the theory allows and do not necessarily follow the prisoner's dilemma "rational" selfish strategy.

The bottom-up initiatives and voluntary efforts reviewed by Ostrom (2009) may actually be only part of the story. While the implementation of carbon pricing is rather a recent and heterogeneous phenomenon, most countries have launched their own strategy to deal with climate change. In some cases, countries bear substantial costs to promote the transition towards a greener economy. The subsidies for renewable energy of the German *Energiewende*, for instance, imply a cost in the order of hundreds of euros per ton of CO_2 abated (Marcantonini and Ellerman 2014). Hence, the main question that this thesis raises is the following: is the lagging implementation of "first-best" instruments of climate policy such as carbon taxes only the result of countries' free-riding behavior?

To address this question, this thesis proceeds in three steps. First, starting from Ostrom (2009), it reviews the evidence provided by the literature on the plausibility of Ostrom's assumption that people may adopt a cooperative stance in global dilemmas as in local commons, and then tests this hypothesis with data for Europe over the period 1990-2007. This is the aim and scope of Chapter 1. Second, it reviews the popularity of carbon taxes and identifies with survey and semi-experimental techniques its drivers and barriers. This is the aim and scope of Chapter 2. Third, it tests whether the popularity of environmental taxes faces similar challenges in local contexts as in global situations. It thus focuses on pricing garbage by the bag schemes and assesses both their effectiveness and acceptability. This is the aim and scope of Chapter 3.

Let us start from Chapter 1. The seminal contribution of Ostrom (2009) provides a powerful intuition (see also Ostrom 2010): despite the global characteristics of climate change, people can commit to curb their emissions as long as they perceive their engagement as part of a shared effort taking place within their social context. As in local commons (cf. Ostrom 1990), the key ingredient necessary to have any chance of cooperation is trust. Trust is necessary to engage in a costly behavior that can be effective only if adopted by more people, with most people being expected to reciprocate the efforts of the others. Ostrom's intuition does not take directly the form of a testable assumption, but can be framed in the light of previous empirical exercises relating trust

with local pollutants (see Grafton and Knowles 2004) and trust with economic growth (see Knack and Keefer 1997; Zak and Knack 2001; Tabellini 2010; see also Putnam et al. 1993; Fukuyama 1995). Hence, the contribution of Chapter 1 is twofold. First, it clarifies the mechanisms through which trust can affect greenhouse gas emissions and, building on the theoretical model of Nyborg et al. (2006), provides a conceptual framework susceptible to frame Ostrom's general ideas. In particular, it provides a series of testable assumptions for each potential channel going from trust to greenhouse gas emissions. Following Chapter 1, trusting individuals may be particularly willing to adopt climate-friendly behavior such as biking to work or installing solar panels on their roofs and may also be willing to accept or even campaign for climate-friendly policies. In the case of biking to work, higher trust is expected to lead to lower energy consumption, whereas in the case of adopting solar panels, higher trust may not imply any energy conservation but can be associated to lower greenhouse gas emissions through the use of greener electricity. Finally, trust may also have a detrimental effect on the climate, if, as some authors maintain, it favors economic growth which is in turn related to higher greenhouse emissions.

Second, Chapter 1 collects data for 27 European countries over the period 1990-2009 and provides evidence in favor of a statistically significant and economically meaningful negative effect of trust on greenhouse gas emissions. That is, the higher the level of generalized trust in a given country, the lower its greenhouse gas emissions, everything else equal. This evidence is the first of its kind. The microeconomic implications are substantial and support the efforts increasingly done by policymakers and practitioners to leverage social effects to spur energy savings and promote renewable energy (see e.g. Cialdini 2003; Schultz et al. 2007; Bollinger and Gillingham 2012; Yoeli et al. 2013; Allcott and Rogers 2014; Graziano and Gillingham 2014). Chapter 1 shows also that trust and social capital deserve a place among the potential determinants of greenhouse gas emissions and may contribute to move beyond the somewhat sterile debate on the Environmental Kuznets Curve by suggesting the introduction of social and cultural factors in the discussion on the cross-country differences in environmental pressures (see Esty and Porter 2005). It may also provide new bases for the analysis of the global governance of the climate commons, with a minority of countries sharing the same characteristics and willing to reciprocate others' efforts and provide positive emissions abatements even when most countries free ride (see Nyborg 2014; Fankhauser et al. 2015).

Yet, future research may not only target the implications driven by the result of Chapter 1, but also the empirical approach from which the result is driven. Indeed,

Chapter 1 does not pretend to provide conclusive and exhaustive evidence and so settle down the question of trust and emissions. Instead, it provides new elements to the discussion on the measurement of trust (see also Glaeser et al. 2000) and paves the way for further empirical analyses on the link between trust and emissions. These analyses can take different directions. First, every channel going from trust to greenhouse gas emissions deserves to be analyzed into more detail, perhaps with the help of new data on trust, climate policy and greenhouse gas emissions, both at the national and subnational level. Second, a similar approach to the one of Chapter 1 could be applied to several examples of pro-environmental behavior, such as the adoption of hybrid cars and solar panels or the participation in carbon offset programs, at either the national or subnational scale. Third, the empirical approach could be substantially improved with the use of instrumental variables, as in Tabellini (2010), so to move beyond correlation and allow for a causal interpretation of the link between trust and greenhouse gas emissions.

Let us now shortly introduce Chapter 2. This chapter aims at better understanding the observed delay in the implementation of carbon taxes. Three reasons may explain this lag. First, the pure free-riding behavior of countries. However, following the discussion around Chapter 1, this explanation cannot be seen as complete. Second, the lack of effectiveness of carbon taxes. In a preliminary stage, the empirical evidence available on the existing carbon taxes is thus reviewed and their effectiveness assessed (see Baranzini and Carattini 2014). Carbon taxes are effective as the theory predicts, provided that the policy is not designed in a way that allows for generous exemptions and exceptions. Carbon taxes also provide important local benefits, mainly driven by better air quality, which can make up for a considerable share of abatement costs. Hence, a lack of effectiveness cannot completely explain the lag in implementing carbon taxes either. Third, the political economy of carbon taxes. This is the way explored by Chapter 2. The theoretical literature already identified lobbying from e.g. energy-intensive industries as a barrier to carbon taxes. For instance, Kirchgassner and Schneider (2003) emphasize the different political economy aspects related with the implementation of environmental taxes and identify the possible winners and losers among industries, politicians and bureaucrats. In practice, the power of lobbying has proven very powerful in avoiding possible energy taxes (cf. Rocchi et al. 2014) or in softening those that were eventually implemented (cf. e.g. Godal and Holtsmark 2001; Bruvoll and Larsen 2004; Lin and Li 2011; Spash and Lo 2012). However, lobbying from energy-intensive industries is probably not the only explanation for the lagging implementation of carbon taxes. Environmental taxes may also be unpopular among

voters. The pressure of people disliking environmental taxes may be so strong to push politicians to abandon their proposed reforms (see e.g. the French case in Deroubaix and Lévèque 2006) or to reject the proposed reforms in a ballot (see e.g. the Swiss case in Thalmann 2004).

Hence, Chapter 2 aims at identifying drivers and barriers to the acceptability of carbon taxes. Its methodology relies on a survey administrated to more than 300 individuals approached in the streets of Geneva. This methodology allows for the expression of respondent's opinion. Applying the insights from experimental economics, some respondents are requested at random to judge a potential "carbon tax", while others a potential "climate contribution". Several explanations are already suggested by the literature for the reticence of people to support energy and carbon taxes, also when they may be net winners. In general, people have a preference for progressive (or at least neutral) taxes, as shown by e.g. Bristow et al. (2010), Kallbekken and Sælen (2011) and Brannlund and Persson (2012). They may also be concerned about competitiveness and employment effects (cf. Thalmann 2004). Another obstacle emphasized by the literature and barely addressed by policymakers is that people often do not conceive the difference between Pigouvian and Ramsey taxes (Kallbekken et al. 2011). Hence, people may fail to understand the incentive effect of environmental taxes and thus neglect any environmental benefit from the new taxes unless revenues are explicitly earmarked (cf. the "issue-linkage" concept in Sælen and Kallbekken 2011). It follows that a recurrent result in the literature is a high correlation between the perceived effectiveness of the environmental tax and its acceptability (cf. e.g. Brouwer et al. 2008; Bristow et al. 2010; Kallbekken and Sælen 2011; Sælen and Kallbekken 2011). In this context, renaming the tax differently can spur its acceptability (cf. Kallbekken et al. 2011; Brannlund and Persson 2012).

Chapter 2 contributes to this literature not only by confirming some stylized facts and broadening their scope but also by rejecting some other conventional wisdoms. On the one hand, it confirms the high correlation between perceived effectiveness and acceptability and finds that this correlation holds also for the perception of co-benefits from carbon taxes, whose existence is often neglected by the people in the sample. Given the relative magnitude of co-benefits with respect to the abatement costs, this novelty comes with very important policy implications in terms of how climate policy could or should be sold (see also OECD 2014). Chapter 2 also confirms the role of earmarking revenues as driver of higher acceptability, above all when revenues are earmarked for environmental purposes. It also describes how the need for earmarking revenues is related with the lack of trust in the government.

On the other hand, Chapter 2 shows quantitatively that the correlation between perceived effectiveness and acceptability persists even if revenues are earmarked. That is, to the contrary of what generally assumed (cf. e.g. Kallbekken et al. 2011), perceived effectiveness and acceptability tend to go hand in hand even when revenues are earmarked. It also finds that perceived effectiveness may matter for acceptability much more than the potential adverse distributional and competitiveness effects. In particular, it discusses how competitiveness effects may not necessarily be a concern for potential voters and how distributional concerns, while present, may not be an obstacle for acceptability. Important policy implications can follow from this new evidence. First, since there may not be a trade-off between effectiveness and competitiveness concerns, acceptability-maximizing policymakers could target the former and renounce to the exemptions often given to energy-intensive industries in the name of the latter. Second, regressive carbon taxes may not be necessarily unpopular, even though there would still be a demand for equity in society that could be met with other instruments. Finally, Chapter 2 provides evidence for an effect of the labeling treatment when revenues are earmarked. Hence, with the sample of Chapter 2, the maximal acceptability would be obtained with a climate contribution with revenues earmarked for environmental purposes. With respect to labeling, Chapter 2 extends to the field the laboratory evidence of Kallbekken et al. (2011).

Two main limitations concern the empirical approach of Chapter 2. The first concern regards the external validity of the survey. Most of the insights rely on the internal validity of the survey, with several questions being asked to the same participants and with the label treatment being randomly allocated, while extrapolating the insights from this sample to a larger population would require them to be externally valid. The sample is drawn from the population of Geneva, which, even though not differing dramatically by the rest of the country in terms of voting behavior on such issues, may have slightly different concerns from the average Swiss citizen. Furthermore, even assuming that the empirical results from Chapter 2 can be extrapolated to the whole country, Switzerland may still represent a special case with respect to other developed countries, including its European neighbors, in particular for what regards the stated concerns about possible distributional and competitiveness effects. The second concern regards the reliability of stated preferences. The most serious obstacle limiting the transposability of stated preferences to real-life decisions is the hypothetical bias, which implies that individuals may want to appear more pro-social and pro-environmental when they answer to survey questions than what they are in reality, since the decisions they take in surveys are not binding. Furthermore, real-life decisions such as voting

may be also influenced by the media and lobbying.

Future research can tackle these concerns by for instance analyzing voting behavior whenever the opportunity arises. While the vote that each individual casts cannot be observed, representative surveys can recover the ballot decisions and allow for comparison with the official data. Such surveys not only allow to understand the behavior and rationales of voters but also those of the citizens that are entitled to vote but choose not to (see e.g. Thalmann 2004).

Chapter 3 applies the analysis of Chapter 2 to unit pricing schemes. In the same spirit, it assesses both the effectiveness and acceptability of pricing garbage by the bag. The issue of households' garbage production shares the same public good properties of climate change mitigation. Households bear the full cost of recycling but only a marginal part of the additional waste management costs generated by an additional unit of garbage that they may send to incineration (or to the landfill). As a result, they have the incentive to under-recycle and over-produce solid waste. To the contrary of climate change mitigation, the burden of excess garbage is confined within each community, which makes this a local public good. Hence, Chapter 3 tests whether the insights of Chapter 2 apply also to a local context. Yet, this local issue has also global implications, related with the remaining chapters of this thesis. Indeed, solid waste combustion is responsible for substantial greenhouse gas emissions associated with very high external costs (gross external damages estimated in the order of magnitude of several billion dollars per year in the United States only, cf. Muller et al. 2011). Hence, the evidence from this chapter shows that pricing garbage by the bag is an additional tool available to policymakers to curb greenhouse gas emissions, while solving a local externality.

Assessing the effectiveness of pricing garbage by the bag presents some important empirical challenges that the existing literature has only partly addressed and met (see Bel and Gradus 2014 for a review). These are represented by the endogeneity in the choice of the policy and the presence of confounders potentially biasing the empirical estimation. Cross-sectional analyses require to control for the potential self-selection of communities into the adoption of pricing garbage by the bag. Time-series analyses need instead to control for the simultaneity of many other factors affecting the level of recycling, absent any control group. Chapter 3 contributes to the literature on the effectiveness of pricing garbage by the bag by tackling both issues. It delivers a causal estimate of pricing garbage by the bag's effectiveness, which is obtained with a difference-in-difference approach relying on an exogenous policy shock. The use of this approach represents a complete novelty in the relevant literature and contributes to

answer the call for causal inference applied to the environmental domain (see Greenstone and Gayer 2009).

In detail, Chapter 3 exploits as exogenous policy shock a ruling decision of the Federal Supreme Court of Switzerland and its consequences for the Canton of Vaud. It uses panel data, with the treatment group implementing pricing garbage by the bag and a control group to allow for the causal interpretation of results. A secondary control group is used in the robustness tests. The data used consist in a panel of households observed twice (before and after the treatment) and official data from a 5-years period. Both datasets lead to the same empirical outcomes. Pricing garbage by the bag is effective in the sense that leads to a decrease of about 40% in the amount of solid waste produced by households. In terms of volume, the decrease is of about 10 liters per capita per week. Household data show that the reduction in incinerated garbage comes with an increase in the frequency of recycling of e.g. organic waste and aluminum. The effect of pricing garbage by the bag is shown to be very persistent, with only two equilibria found in the data: a high-garbage equilibrium without the policy and a low-garbage equilibrium with the policy.

Chapter 3 does not include a cost-benefit analysis based on the estimates for pricing garbage by the bag's effectiveness that it provides but implicitly assumes that the behavioral change that it measures is large enough to in principle justify the policy's implementation. In fact, a cost-benefit analysis as in Kinnaman (2006) can be challenged on many grounds. In the particular case of Kinnaman (2006), the cost-benefit analysis relies on estimates of policy effectiveness coming from very different empirical approaches and based on different types of unit pricing (i.e. not only pricing garbage by the bag), which are in turn associated to different price-elasticities of demand (see Bel and Gradus 2014).

In terms of acceptability, Chapter 3 exploits the *ex-ante*/*ex-post* variation in policy to assess the changes in people's perceptions and in the popularity of pricing garbage by the bag, always comparing the treatment group with the control group. This approach is completely novel in the literature on the acceptability of environmental taxes. *Ex-ante,* Chapter 3 confirms the main obstacle to environmental taxation emphasized by Chapter 2, i.e. perceived ineffectiveness. However, it also shows that *ex-post* both the perception and the acceptability of pricing garbage by the bag substantially improve in the treatment group, approaching the levels observed in the control group. Chapter 3 thus discusses the key elements potentially driving this improvement in acceptability.

The findings related with acceptability come with strong policy implications: if most resistance against pricing garbage by the bag disappears once the policy effectiveness

is directly experienced by individuals, it will be reasonable to expect pricing garbage by the bag and similar instruments to be more diffused if only people could have the chance to have a try. These implications may also be particularly far-reaching: assuming that the dynamics illustrated by Chapter 3 also apply to other types of environmental taxation, trial periods may become a very powerful tool to boost the implementation of effective instruments of climate policy (see also Kallbekken and Sælen 2011). The analysis of trial runs may thus represent a very promising field for future research, as some preliminary evidence from the laboratory seems to confirm (see Cherry et al. 2014).

Another avenue for future research is represented by the assessment of pricing garbage by the bag's distributional effects. Chapter 3 estimates an income elasticity of 0.4, implying that pricing garbage by the bag is a regressive policy. However, the analysis in the chapter does not go beyond an everything-else equal assessment. This analysis is thus partial. The inclusion of two additional effects is needed to complete the analysis. First, in most situations, pricing garbage by the bag is supposed to replace other taxes funding waste management. Second, pricing garbage by the bag tends to reduce waste management costs, therefore implying a net decrease in taxes. Hence, a promising direction for future research may consist in assessing in full the distributional effects of pricing garbage by the bag and of other similar policies. Of course, the results are likely to vary with the context studied, as they depend on the way waste management is financed *ex-ante*.

Overall, this thesis sheds new light on the question of environmental dilemmas. It examines from different perspectives the issues related with the application of market-based instruments to environmental externalities and provides original evidence-based insights to the political economy of commons. While different in terms of methodology, all chapters share the same behavioral implications. Individuals may be willing to play cooperatively in environmental dilemmas if they trust others to do so and people's reticence to environmental taxes most likely stems from a general suspicion with respect to the taxes themselves rather than from a pure unwillingness to cooperate. With the hope to contribute to any extent to solve the urgent issue represented by climate change, all chapters in this thesis provide practical insights on how to potentially overcome such reticence.

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Chapter 1

Unconventional Determinants of Greenhouse Gas Emissions: The Role of Trust*

Social norms have been included in the theory of collective action to overcome difficulties in explaining why commons may perform better when self-regulated. The role of trust has been identified in several contexts of local social dilemmas, but only recently has been extended to global commons, based on large descriptive evidence collected by Elinor Ostrom. However, no quantitative evidence was available until now. Using a dataset of 29 European countries over the period 1990-2007, we provide empirical evidence in favor of the role of trust in global dilemmas. We find a non-negligible impact of trust on greenhouse gas emissions, which can support Ostrom's intuition on the social roots of pro-environmental behavior.

*Chapter written with Andrea Baranzini and Jordi Roca Jusmet. Comments from Jeroen van den Bergh, Valentina Bosetti, Patrick Gagliardini, Rafael Lalive, Nicole A. Mathys, Marcelo Olarreaga, Santiago Sánchez Pagés and Massimo Tavoni really contributed to improve this paper. I thank as well participants to the 10^{th} biennial conference of the European Society for Ecological Economics in Reims-Lille and seminar audience at the Graduate Institute, Geneva, and Fondazione Eni Enrico Mattei, Milan, for helpful comments. Tobias Böhmelt and Jan Burck kindly provided their data on climate policy. Chapter awarded the *Environmental Policy & Governance* Best Student Paper prize from the European Society for Ecological Economics and forthcoming in *Environmental Policy & Governance*. Working paper version available as Carattini et al. (2013).

1.1 Introduction

Climate change is one of the principal challenges of this century. We observe two main patterns in the way human beings deal with this issue. At the global level, the day of a binding agreement including all principal emitters and targeting a sharp reduction in worldwide greenhouse gas emissions is still to come, although recent Conferences of the Parties suggested a potential deadline for binding abatement targets in 2020. Stalling negotiations are in line with the main theory of collective action, predicting large free-rider behavior and thus huge difficulties in solving this type of global public good dilemma (cf. Olson 1965; Hardin 1968). Indeed, since the costs of climate change mitigation are local while the benefits are mainly regarded as global, a prisoner's dilemma arises. In this context, non-cooperative behavior is supposed to be the only rational strategy and the public good is not provided. However, individuals may depart from this narrow definition of "rationality" and social dilemmas may be better addressed with different lenses: "A more fruitful approach may lie in permitting the possibility that the person is *more* sophisticated than the theory allows" (Sen 1977, p. 341) and does not follow the "rational" selfish strategy. Indeed, even though most governments are reticent to engage in coordinated international policies, examples of unilateral policies, local actions and individual ecological behaviors are increasingly available. A small set of countries already adopted carbon taxes to stimulate a shift toward a greener economy (Baranzini and Carattini 2014). In this paper, we aim at contributing to explain why countries and individuals may adopt or accept climate-friendly behaviors and policies, in spite of the global public good characteristics of climate change mitigation.

We draw on the contributions of Elinor Ostrom and apply an empirical framework to determine countries greenhouse gas emissions. In our paper we focus on the importance of social norms, and in particular of trust, in the determination of individual and collective behavior. As highlighted by Ostrom and Ahn (2003): "The ideas fundamental to the social capital approach cannot be entirely captured by the first-generation collective-action theories that tend to reduce 'cultural' aspects such as trust, trustworthiness, and norms to incentives embedded in social structures of interaction. [...] Trustworthiness is an independent and nonreducible reason why some communities achieve collective action while other fail" (p. xvi).

The concept of trust, understood as mirroring an expectation of trustworthiness, has been applied to the problem of common pool resources and local environmental public goods to explain why self-organized solutions may perform better than regu-

lated environments. A recurrent illustration refers to water management in developing countries: field evidence shows that overuse could be lower with self-management than with external control, i.e. the prisoner's dilemma does not necessarily hold when people trust each other (cf. Joshi et al. 2000). Out of the environmental sphere, the concept of trust has been used in the development literature, in particular by Putnam et al. (1993) and Fukuyama (1995), who elect trust as the key social value for sustained economic growth, and by Knack and Keefer (1997), Zak and Knack (2001) and Tabellini (2010), who show the positive role that trust plays in supporting growth.

In this paper, we aim to explore whether trust has an impact on greenhouse gas emissions, by referring conceptually to the literature criticizing the conventional collective action theory based on local and communitarian environmental solutions, while borrowing the empirical methodology from applications in development economics. Ours is not the first attempt to relate social norms, namely trust, with global public goods such as climate change. The seminal paper of Ostrom (2009) already disputes the validity of the traditional view, which contends that the global scale of climate change hampers the emergence of grassroots collective action and dispersed forms of unilateral action, i.e. cooperation is even more unlikely than with local issues. Supported by the collection of case, field and laboratory studies presented in Poteete et al. (2010), Ostrom stresses the limits of conventional theory arguing that it can fail to predict the realized outcome also with global issues, especially whenever participants see each other as trustworthy (i.e. "effective reciprocators"). In particular, she suggests that the same mechanism of trust that leads commons to be successfully managed by self-organized institutions could be effective also with global issues. That is, in a given context, individuals can commit to reduce their own emissions and comply with their commitment, especially when they trust that others are also sharing the same responsibility and engaging in the same social behavior. To see this mechanism at work, we need to scale down the focus from the global perspective. Thus we can realize how social norms help overcoming the global property of climate change, promoting effective local efforts.

In the empirical side, Grafton and Knowles (2004) propose a series of cross-sectional regressions attempting to identify an effect of social capital on several measures of local environmental performance. They find very little evidence in favor of an effect of social capital, including trust. The authors point to a series of empirical difficulties related to the dataset, concerning the measures of both social capital and environmental quality, which could explain their outcome.

Our aim is to generalize Ostrom's intuition and to assess whether the effect of trust is visible not only in small-sized case studies, but also at an aggregated level. In this

way, we improve the seminal contribution of Grafton and Knowles (2004) in four ways. First, the measure of environmental quality that we use concerns global pollutants rather than local contaminants. We thus test the full extent of Ostrom's hypothesis on global dilemmas. Second, this measure is compatible across time and countries and does not present the weaknesses of indices and similar built-in measures of environmental quality. Third, we use a larger set of data that allows for multivariate panel analysis and fixed effects, which limit the risk of omitted variable bias and allow focusing on changes over time. Fourth, our dataset of European countries is composed of relatively similar economies, also contributing to reduce the bias possibly caused by missing variables.

Hence, we perform an econometric analysis assessing the effect of trust on greenhouse gas emissions. We end up with a negative coefficient implying a decline in emissions of 0.24% following a percentage increase in trust, *ceteris paribus*. This fresh evidence is in line with the updated theory of collective action and supports its underlying economic intuition.

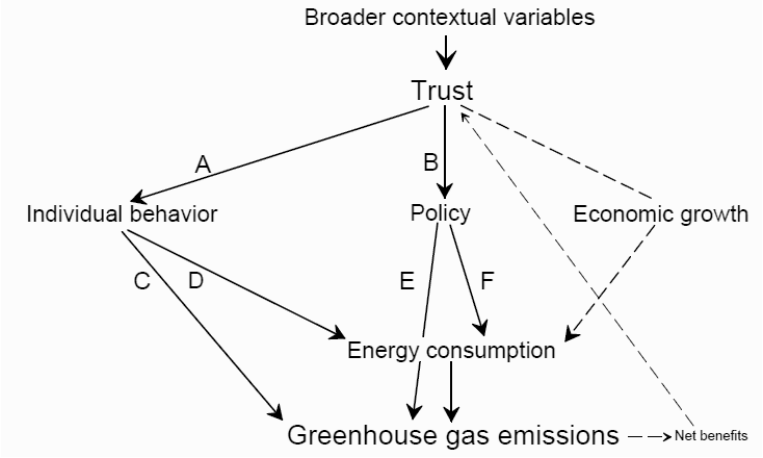
The remainder of the paper is structured as follows. Section 1.2 reviews the economic motivations. Section 1.3 presents the data, discusses the methodological issues related with the measure of trust and describes the econometric strategy. Section 1.4 focuses on empirical results. Section 1.5 concludes.

1.2 Linking trust and greenhouse gas emissions

We expect trust to have a threefold impact on greenhouse gas emissions. First, trust may have a direct effect by promoting pro-social and environmentally-conscious behavior at the individual level (e.g. biking to work rather than driving), as illustrated by the large survey of Pretty and Ward (2001) and Poteete et al. (2010). According to the latter, trust plays a crucial role as the norm defining the actual level of cooperation (cf. Figure 1.1): if agents acting in a given context perceive most individuals as reciprocators (i.e. trustworthy), we may expect them to adopt a more cooperative behavior (e.g. pro-environmental). In this way, trust generates reciprocity: a mechanism based on the social "obligation" to reciprocate leads people to invest in collective action being confident of other people doing the same (Pretty and Ward 2001).

Cooperative behavior in general and environmental preferences in particular may also come from intrinsic moral norms. Although in society there may be a fraction of "Kantian" mostly unconditional cooperators tending to behave ethically (see the discussion in Knack and Keefer 1997 and Roemer 2010), their effort may not be sufficient to cope with climate change. This paper thus focuses on conditional cooperation,

Figure 1.1: From trust to greenhouse gas emissions.



Note: Own figure based on Poteete et al. (2010). According to the authors, the level of trust that other participants are reciprocators affects the level of cooperation and in turn generates a beneficial outcome, which in this framework would be a reduction in emissions. The effect of trust on emissions goes through three channels, as described in the text. Paths A to F are detailed below. The figure is clearly not exhaustive. Our focus is on trust, but other factors may affect individual behavior, policy or economic growth. In the case of e.g. individual behavior, see the reference to moral norms and environmental awareness with respect to the model of Nyborg et al. (2006).

where the expectation of reciprocation shapes individual behavior. Nyborg et al. (2006) formalizes it as follows. For a given individual, choosing a more expensive green product over the grey alternative yields a self-image benefit from behaving in tune with the social norm. Hence, this benefit depends on what the norm is, as well as on the overall external environmental benefit, which relates to environmental awareness and consumer perceived effectiveness. That is, the larger the share of consumers going green, the larger the self-image benefit. If benefits from being green exceed the cost differential, the total payoff (i.e. personal welfare) is higher buying green. Empirical evidence from a choice experiment supports this formalization: testing the willingness-to-pay of Swedish students to withdraw emissions allowances from the European carbon trading market, Lindman et al. (2013) show that the expected participation rates at the population level have a positive effect on student's voluntary participation in the carbon market. In most cases individuals cannot really observe how green the others may be, but do have a general expectation of the level of trustworthiness in the context where they live. In this spirit, we relate trust to pro-environmental behavior (channel A in Figure 1.1).

Second, following Ostrom (2009) trust may have an impact on local, regional and national environmental policy as it influences collective action. Although there is some theoretical and empirical literature analyzing the effect of environmental policy on trust and intrinsic motivation, suggesting a crowding-out if the policy change makes agents less trustful (see e.g. Frey 1997; Cardenas et al. 2000; Frey and Jegen 2001), the reverse link from trust to environmental policy is still largely unexplored. Ostrom posits that trust and environmental policy are complements: in some cases, only collective action allows policies to exist and be followed in a manageable way (i.e. without excessive costs of enforcement). She also predicts a crowding in, if the policy change makes agents more trustful (Ostrom 2009). Trust is thus the key for having diligent and proactive citizens. She explains in this way the large list of environmental programs undertaken at any level (municipal, regional, inter-regional, etc.) and mentioned in her work. Her intuition is supported by the empirical evidence of Owen and Videras (2008). In a cross-sectional examination of 66 countries, the latter find that trust is positively correlated with the amount of local Agenda 21 programs implemented in a given place. The magnitude of this effect is considerable: the authors suggest that an increase of 10% in trust lifts the expected number of programs by up to 70%.

From a conceptual perspective, this second link could be introduced in the model of Nyborg et al. (2006) by assuming that the green option does not refer only to a green good, but also to a basket of e.g. climate policies. In this perspective, voting green may thus generate a similar self-image benefit as buying green.

Further evidence in this sense comes from a growing body of literature following an environmental psychological approach. Stern et al. (1999) theorize how engagement in collective action aiming at affecting climate policy, both actively (e.g. writing letters, contributing financially to environmental movements, demonstrating, i.e. environmental citizenship and activism) and passively (e.g. accepting higher taxes), responds to a feeling of obligation to contribute to the provision of a collective good. In this framework, social and personal norms interact and contextual factors such as social expectations and trust contribute to explain pro-environmental behavior in the public sphere along with moral motivations (Stern 2000). Survey-based empirical evidence supports this norm-activation mechanism for many measures of policy-related collective action such as being in favor of higher energy prices (i.e. energy taxes) and of subsidies to energy efficiency and renewables, signing petitions for tighter environmental laws, supporting green taxation of imports, and so on and so forth (see e.g. Stern et al. 1999; Gaerling et al. 2003; Steg et al. 2005 and the survey of Steg and Vlek 2009).

Trust may thus affect policy (channel B in Figure 1.1). Yet, we acknowledge that in

some cases Ostrom's intuition may look counterintuitive. Actually, in absence of trust (or at very low levels) there may be some substitution between policy and trust. For instance, Baranzini et al. (2010) consider a global public good problem such as tropical forest conservation and find that when people do not expect spontaneous efforts by the others, they prefer to contribute to a mechanism that is strict and enforceable (i.e. a hypothetical global tax) compared to a mechanism based on voluntary contributions. However, one would argue that in such situation it would be unclear who would promote such a policy. In reality there is no global tax to protect tropical forests. In our view, despite the positive demand for environmental policy, the latter fails to rise due to the same reason that leads to the development of this demand, i.e. the lack of trust. That is, at very low levels of trust we may see a pattern of substitutability on the demand side which is however not matched by policy suppliers (i.e. institutions, since collective action is lacking). We thus suggest that pro-social behavior and policy are more likely to go hand in hand rather than be substitutes.

Third, trust may influence emissions through the channel of economic growth (see Knack and Keefer, 1997; Zak and Knack, 2001). However, our focus is on trust and collective action toward environmental-friendly changes. For that reason, our empirical strategy is limited to the impact of trust on environmental behavior and policy. We would thus not assess the full net effect of trust on greenhouse gas emissions, which may be positive. Since the channel through economic growth is not considered in our empirical specification, we present the relative path in Figure 1.1 as a dashed line.

Figure 1.1 summarizes. The mechanism of Poteete et al. (2010) is updated by introducing the link between trust and greenhouse gas emissions. This link is expected to go mainly through lower energy consumption. In this sense, energy consumption acts as a mediator, in the spirit of Baron and Kenny (1986). Indeed, we would expect an increase in pro-environmental behavior (A) to lead to lower energy consumption (path D), as we would expect local, regional and national environmental policy to do it (paths B and F). In theory, both individual behavior and policy could also affect emissions without passing by the level of energy consumption, e.g. by affecting the energy-mix (i.e. technological development and adoption) or non-energy emissions. That is why we include two additional arrows for paths C and E[1]. Finally, following Poteete et al. (2010), we add the option of a feedback mechanism, reinforcing the existing pattern. In the case of climate change, direct benefits of climate policies or green behavior may not be visible for the individual, but those efforts could contribute to more perceptible

[1]Path E relates to the so-called "weak Porter hypothesis" (see Baranzini and Carattini 2014 and Ambec et al. 2013 for an empirical review; Acemoglu et al. 2012 for a theoretical analysis).

local co-benefits, e.g. in terms of better air quality. However, we do not expect this effect to be particularly large as to be an issue for identification. We use again a dashed line.

1.3 Methodology

1.3.1 Data sources and measurement issues

We access the Eurostat database for 30 European countries over 1990-2007, namely 27 members of the European Union (Greece is excluded, due to missing values, as well as the recent member Croatia) and the EFTA members Iceland, Norway and Switzerland. Our sample includes 9 transition economies. Eurostat provides the data for all the explicative variables used in the econometric model except trust, which comes from the World Values Survey (WVS)[2]. The variable trust that we use in this study is the share of respondents marking the answer "Most people can be trusted" when asked "In general, do you think that most people can be trusted, or that you cannot be too careful in dealing with other people?". The alternative answer is "You cannot be too careful in dealing with other people". The number of individuals surveyed depends on both timing and country: observations vary between a minimum of 375 (for Malta in 1991) and a maximum of 2574 (for Belgium in 1990). In general, the largest part of our values is given by a sample reaching or exceeding 1000 individuals.

Unfortunately, we do not possess yearly observations for trust, given that the survey is administered sporadically and with different timing across countries (i.e. one wave can take more than one year to be completed). The latest available wave is of 2007. For this reason, the sample ends in 2007 and is composed of 540 observations maximum. Countries included in the sample represent more than 10% of world greenhouse gas emissions (UNEP 2012).

Main descriptive statistics are provided by Table A.2. Greenhouse gas emissions present very large variation, since they depend closely on the economy's size. In per capita terms, each European citizen emits about 11 tons of CO_2-equivalent emissions per year on average over the observed period. As shown by Figure 1.2, per capita greenhouse gas emissions decreased in European countries in the early 90s and leveled off thereafter. However, in the case of transition economies, the early 90s are characterized by a sharp change in the economic structure and a heavy collapse of output, resulting in a strong decrease in emissions. Afterward, transition economies switched to a recovery

[2]See Table A.1 for data sources.

path, but emissions lagged behind until 2000. All this suggests dealing carefully with this subset of countries.

Manufacturing represents on average about 20% of European GDP. Since Eurostat does not include mining and fossil fuel extraction in the category manufacturing (but does include fossil fuels refining), we add mining and resource extraction to manufacturing whenever data are available (cf. Xu and Ang 2013). This is economically justified by the large energy-intensity of mining and resource extraction, which we relate to the so-called "composition effect". Looking at the data, we see an important structural change taking place in European economies during the 90s and the 2000s, with the largest drops in manufacturing share being related with transition economies (from more than 30% of GDP to 20% in about two decades).

As it is common in the literature, trade openness is given by the sum of imports and exports over GDP (trade intensity ratio). Trade openness evolves similarly for both transition and Western European economies, with the average moving from about 40% of GDP in 1990 to slightly less than 60% in 2007. However, cross-country differences are important. On average, transition economies are related to larger trade openness. Yet, Western small open economies such as Belgium, Ireland, Luxembourg or Malta show even larger values.

Our main variable of interest is trust. Data inspection shows some supportive variation over time in the level of trust[3]. For instance, trust in Spain moved from 34.3% in 1990 up to 39.8% in 1995, but then decreased to 34% in 2000 and 20% in 2007. Trust also possesses a large variation between countries. Although the average shows moderate levels of trust for Europe (i.e. one out of three respondents stating that most people are trustworthy), extremes indicate relatively low levels of trust for Cyprus, Portugal and Romania (with values below 10%) and large levels of trust at the other end of the spectrum, mainly related with Scandinavian countries (about two out of three respondents trusting most people).

Since trust is not directly observable, it can only be approximated from individual perceptions in surveys. A long list of potential biases could raise from survey measures, such as selection issues, translation difficulties (i.e. different framing) and response bias (cf. Knack and Keefer 1997). For example, in their study about trust and economic

[3]We start with 84 values for trust and interpolate linearly to reach 340 observations. In a conservative vein, we do not extrapolate. Furthermore, by extrapolating we would have had to deal with negative (thus zero) values, which is a very extreme case. The number of observations used for the estimations varies depending on the completeness of control variables. Own computations show that the way we ipolate does not have a particular impact on the empirical findings in the next section, comparing with cubic or cubic spline ipolations and multiple imputation techniques. We match the WVS measures of trust for Great Britain and West Germany with Eurostat variables for United Kingdom and Germany, respectively (cf. Knack and Keefer 1997).

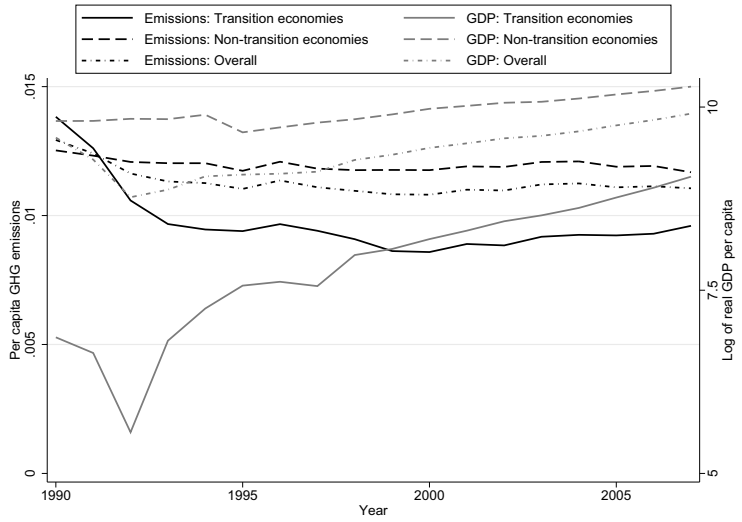
growth, Knack and Keefer (1997) point to a selection bias related to the WVS measure of trust may leading to over-correlation with education and income. However, they argue that this issue mainly applies to developing countries. Ostrom and Ahn (2003) present other drawbacks of survey measures related to trust. For instance, it seems that measures from the General Social Survey, another large-scale survey similar to the WVS but administered only to the US population, do not lead to good forecasts of individual cooperation in the lab.

However, other studies reviewed by Ostrom and Ahn (2003) provide a more optimistic picture, showing that although general survey questions may struggle to depict the trust pattern (e.g. if a participant trust the other participants when playing first), they are generally successful in predicting trustworthiness (e.g. the amount of money given back by trustees if players in the first round decide to trust). Furthermore, Knack and Keefer (1997) not only provide a list of potential risks linked to the WVS measure of trust, but also favorable evidence for its application. In particular, they test whether the ambiguous terminology used in the question (i.e. the reference to "most people") may lead respondents to think to other people as their family, which is not necessarily the scope of trust for our study, since we are interested in trust in the others in a large sense[4]. The authors point out that in low-trust countries a large share of interactions probably occurs within the family, which could eventually lead to a bias. Yet, they find a low correlation (of 0.24) between the WVS measure of trust and the measure of trust in the family. We are thus more confident that our variable measures trust in the others in a large sense. The authors also look at the nexus between the WVS measure of trust and the share of returned wallets in a cross-country experiment wherein wallets were "lost" with 50$ in cash and a card with the owner's contact, finding a supportive correlation of 0.67. In addition, correlations tend to get higher when controlling for income per capita (thus trying to simulate the reaction to a purchasing-power-adjusted "lost" wallet, i.e. testing individuals' "real" trustworthiness; see also Grafton and Knowles 2004).

In the same vein, we examine the link between the measure that we choose for this study ("Most people can be trusted") and additional measures of trust that were included in the WVS, although for some waves only. In particular, we consider the answers to the questions "Trust: other people in country", "Do you think most people try to take advantage of you?", "Trust: people you know personally", "Trust: people you

[4]More precisely, we shall say that we mainly focus on "intrinsic reciprocity" rather than "instrumental reciprocity". Knack and Keefer (1997) use the term "generalized trust" referring to the same concept. Cf. Sobel (2005) for a discussion on terminology and sound economics of reciprocity.

Figure 1.2: Evolution of GHG emissions per capita over 1990-2007 for the whole sample and subsets of countries.



Source: Own computations.

meet for the first time" and "Trust: your neighborhood". This investigation confirms our priors. Trusting other people in country is positively correlated with the measure of trust that we use. We find positive and significant links both in correlation tables and with country-specific fixed-effects panel regressions for both the positive answers, viz. "Trust completely" and "Trust a little", as well as for the sum of the two[5]. Therefore, we are confident that the national measure of trust that we include in our empirical framework makes sense and captures a plausible range of social interactions to be linked with collective action.

"Take advantage of you" is very highly correlated with trust (correlation of 0.88). The correlation is positive since the variable is coded with a 10 points scale whose maximum indicates an expectation of full fair treatment. "Trust: people you know personally" and "Trust: people you meet for the first time" are strongly correlated between themselves (0.75) and with "Most people can be trusted" (0.6 and 0.72, respectively). Since trust is self-reinforcing and can be accumulated, it follows from practice that people tend to apply their own experience in shaping their everyday behavior while interacting with new agents (Pretty and Ward 2001).

[5]All following measures except "Take advantage of you" are coded according to the following answers: "Trust completely", "Trust a little", "Not trust very much" and "Not trust at all". We use the two positive answers and their sum (as percentage share of total answers).

The correlations for "Trust: your neighborhood" goes in the same direction. It is correlated at 0.84 and 0.86 with "Trust: people you know personally" and "Trust: people you meet for the first time", respectively, and at 0.6 with "Most people can be trusted". The evidence concerning these variables is encouraging since we focus on a global dilemma that needs to be dealt with through cooperation between people at different scales[6]. Therefore, we are confident that the variable trust that we chose from the WVS has the potential for performing well and can thus be used in quantitative studies, even in the case it would measure more trustworthiness than trust (cf. Knack and Keefer 1997; Pretty and Ward 2001; Ostrom and Ahn 2003). Moreover, we are reassured that our measure performs well in explaining trust between citizens of the same country as well as in narrower contexts.

1.3.2 Econometric approach

Starting from earlier empirical works on environmental quality (see in particular Antweiler et al., 2001) and following the previous discussion on trust and emissions, we may suppose that the relevant drivers of per capita greenhouse gas emissions are the level of per capita income, the economy's composition, the economy's openness to trade and the level of trust as given in the following equation:

$$\begin{aligned} Emissions_{i,t} &= \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} \\ &\quad + \beta_4 Trust_{i,t} + \epsilon_{i,t} \end{aligned} \tag{1.1}$$

where $Emissions_{i,t}$ stands for per capita greenhouse gas emissions at time t in country i (in log); $GDP_{i,t}$ is real GDP per capita (in log); $Manufacturing_{i,t}$ is the aggregated industrial sector's share in the economy; $Trade_{i,t}$ measures trade openness; $Trust_{i,t}$ is the share of population showing trust as measured by the WVS; a_i is a country-specific fixed effect and $\epsilon_{i,t}$ represents the error term.

The estimated coefficients can be directly interpreted in terms of elasticities, since all variables are in logs or in shares.

The use of panel-data methods allows for different specifications, in particular the use of fixed- and random-effects estimators. In their seminal contribution, Antweiler et al. (2001) evaluate the limits of one or the other approach in a similar framework in which

[6] All correlations we refer to are statistically significant at least at 10%. However, further studies are needed to have more robust results. Indeed, none of these variables is included in all WVS waves as it is "Most people can be trusted".

they have a panel of 293 observation sites measuring sulfur emissions in 109 urban areas across 44 countries, and look for the effect of trade on emissions. In particular, they remark that fixed-effects estimators treating country-specific unobserved characteristics as constants are appropriate when the aim is to apply the model to the countries in the sample, as we do. In our framework, it would be difficult to argue that our set is a random draw of countries from a larger underlying population. Inconsistency related to omitted variables would be the consequence of applying random effects when not appropriate, whereas the intrinsic drawback of a fixed-effects model is represented by the fixed effects themselves, i.e. the need of simplifying the model by assuming country effects to be constant and focusing on variation over time. The Hausman test (Hausman, 1978) supports the theoretical arguments. As a consequence, we introduce country-specific fixed effects in (1)[7].

Except for trust, the determinants of emissions included in (1) are standard with respect to the literature. We control for structural changes in the composition of the economy using the share of manufacturing, following Cole (2000), Cole (2004) and Buehn and Farzanegan (2013). Then, we take into account the remaining effect of income per capita, similarly to e.g. Antweiler et al. (2001). Observing the effect of trade openness is central in Antweiler et al. (2001) and in other works dealing with geographical carbon leakage. De Melo and Mathys (2010) review the main links between trade and the environment: trade liberalization may increase economic activity (but we already control for GDP per capita), may lead to specialization, displacement of polluting activities and structural changes (but we already control for most energy-intensive industries) and may also affect the type of technology used to produce goods and services within the country. We expect the measure of trade openness to capture predominantly the last effect.

Energy consumption is a very recurrent control variable in the literature (cf. Buehn and Farzanegan 2013), but it is not included in model (1), which estimates the final effect of trust on emissions (see Figure 1.1). Energy consumption enters model (2), whose role is twofold. First, it tests the effect of energy consumption on emissions, which is expected to be positive and significant. Second, it tests for residual mediation. Provided that equation (1) shows a significant effect of trust on emissions, if energy mediates trust, the relation between the latter and emissions should be substantially

[7]The Hausman test rejects the null of always consistent random-effect estimators with a Chi-2(5)=80.12 and Chi-2(4)=8.32 with and without per capita energy consumption, respectively (p-value of 0.0000 and 0.0804). The Breusch and Pagan Lagrangian multiplier test for random effects gives Chi-2(1)=1025.08 and Chi-2(1)=1161.83, respectively (p-value of 0.0000 in both cases).

reduced or even no longer significant[8]. Model (2) is given as follows:

$$\begin{aligned} Emissions_{i,t} &= \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} \\ &\quad + \beta_4 Trust_{i,t} + \beta_5 Energy_{i,t} + \epsilon_{i,t} \end{aligned} \tag{1.2}$$

where $Energy_{i,t}$ stands for per capita gross inland energy consumption (in log). A last step is required for mediation, testing the effect of trust on energy (paths A plus D and B plus F). If energy is a valid mediator, the coefficient for trust should be significant. Model (3) displays then an analogous specification for energy consumption:

$$Energy_{i,t} = \alpha_i + \beta_1 GDP_{i,t} + \beta_2 Manufacturing_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Trust_{i,t} + \epsilon_{i,t} \tag{1.3}$$

In theory, additional levels of mediation could be tested. For instance, paths A and B could be tested by e.g. controlling whether environmental policy does act as a mediator from trust to energy consumption and in what extent. However, we face important shortage of data on policy, as discussed in the next section.

To summarize, the expected impacts of included variables are the following:

- Real income per capita (+): although there is no clear-cutting evidence on the precise role of income per capita on global emissions, a general consensus points to a positive effect due to the dominance of the so-called scale effect.
- Manufacturing (+): we expect industry to be on average more emissions-intensive than services and an increase in the share of manufacturing to be positively related with emissions.
- Trade (±): there is no conclusive evidence on the effect of trade on emissions, even if we control for income per capita and manufacturing.
- Trust (–): trust is supposed to foster collective action toward cleaner goods, greener attitudes and perhaps more effective environmental policy. We thus expect trust to decrease emissions by reducing energy consumption.

[8] Baron and Kenny (1986) refers to "perfect mediation" when the residual effect of the independent variable on the dependent variable controlling for the mediator is not statistically different from zero. In this framework, a positive residual effect would imply that the effect of trust on emissions is mediated also by the energy-mix and non-energy emissions, i.e. paths C and E. Instead, a non-significant coefficient for trust would suggest that almost all mediation goes through energy consumption, although we would refrain from calling it perfect mediation for straightforward empirical reasons. In our view, this is the best way to assess the impact of trust on the energy-mix, which is hardly available in the data. Hence, we omit a specific model for this path but still test its plausibility adding some variables to the main specifications (see next section).

- Energy (+): energy consumption is directly and positively linked with emissions, provided that energy sources are mainly fossil fuels.

We discuss the outcome of the estimations in the next section.

1.4 Empirical results

Estimation results for models (1), (2) and (3) are displayed by Table 1.1. Column (1) and (2) show the estimates for model (1), testing the direct effect of trust on greenhouse gas emissions[9]. Column (1) includes transition economies, whereas all other columns do not. Regressions in columns (1) and (2) provide very large goodness of fit, however in large part driven by fixed effects, as shown by the difference between overall- and within-R^2. Robustness tests for model (1) without transition economies are shown in Table A.3. Results are robust both to heteroskedasticity and autocorrelation. Indeed, the Wald test rejects the null of homoskedasticity in our panel, as well as the Breusch-Pagan (Cook-Weisberg) test. We thus allow errors to be heteroscedastic in Table A.3, where model (1) is estimated using heteroscedastic-consistent White standard errors and bootstrapped standard errors (with 50 replications), cf. columns (2) and (3), respectively. Significance is only slightly reduced. Then, the Wooldridge test for first-order autocorrelation rejects the null hypothesis of no autocorrelation. We also allow for autocorrelation in the residuals estimating Driscoll-Kraay heteroscedastic and autocorrelated standard errors, cf. column (3). Coefficients of interest are still statistically significant. This holds true for the whole sample, i.e. including transition economies. We also test for multicollinearity: for model (1) the mean variance inflation factor is 6.96 with fixed effect, 1.35 without. Both values are below the common threshold value of 10, the second is even below the more restrictive threshold value of 5. Multicollinearity is not an issue also for model (2), which includes energy consumption as a regressor, and model (3).

We start commenting reported estimates in Table 1.1 by focusing on columns (1) and (2). Coefficients for most control variables behave as expected. Since we control for manufacturing (a proxy for the composition effect), the coefficient for GDP per capita is supposed to capture both scale and technique effect[10]. This coefficient is negative and significant with the full sample (1), but becomes positive and significant when transition countries are excluded from the sample (2). The case of transition economies

[9] The model is assumed to be linear with logs and estimated with OLS.

[10] In this sense we follow the standard approach in the literature, even though some conceptual doubts can be casted about the plausibility of a technique effect (cf. Roca 2003; Dinda 2004).

Table 1.1: Empirical results based on model (1), (2) and (3)

	Greenhouse gas emissions			Energy consumption
	Model (1)		Model (2)	Model (3)
	(1)	(2)	(3)	(4)
Trust	-0.269** (0.114)	-0.242** (0.110)	0.022 (0.744)	-0.321*** (0.101)
Real GDP per capita	-0.023** (0.011)	0.088*** (0.033)	-0.070*** (0.024)	0.192*** (0.030)
Manufacturing	1.414*** (0.240)	2.241*** (0.344)	1.106*** (0.238)	1.384*** (0.317)
Trade	-0.210*** (0.068)	-0.569*** (0.115)	-0.440*** (0.076)	-0.157 (0.105)
Energy consumption	-	-	0.821*** (0.054)	-
Constant	-4.045*** (0.152)	-5.080*** (0.333)	0.805* (0.446)	-7.171*** (0.307)
Country fixed-effects	Yes	Yes	Yes	Yes
Observations	257	197	197	197
Countries	29	20	20	20
Within-R^2	0.277	0.287	0.694	0.327
R^2	0.970	0.970	0.987	0.983

Source: Own computations.

Notes: Standard errors in parentheses.

*,** and ***: significance at the 90%, 95% and 99% confidence levels, respectively.

The dependent variable is greenhouse gas emissions per capita, in logs. Panels are unbalanced.

Columns (2) to (4) do not include transition economies.

is exceptional. For instance, Millock et al. (2008) find a very large technique effect for CO_2 emissions in transition economies. Their explanation refers to the simultaneous heritage of devastated environmental resources and unsuccessful planned economies in ex-Soviet countries. In particular, they mention a series of environmental stresses especially related to ex-communist countries, many of them being linked with global pollutants such as greenhouse gases. Jobert et al. (2010) use the terminology "ecologists despite themselves" for Eastern European countries that experienced the collapse of the Soviet Union. Overall, the positive coefficient for GDP per capita is in line with most studies focusing on global pollutants and in particular CO_2, which represents the bulk of greenhouse gas emissions (see e.g. Lin and Li 2011 for a recent assessment).

In line with expectations, a greater share of manufacturing implies higher emissions. Taking the coefficient of column (2), an increase of 1 percent in the share of manufacturing leads to an average increase in emissions of 2.2 percent, everything else fixed (cf. e.g. Jobert et al. 2010 for a similar finding and discussion).

Trade openness is associated to a negative effect. Since we control for the share of manufacturing in the economy, we expect this effect to be related with the technique

effect, i.e. the exposition of exporters to new markets with own standards, the effect of foreign investment and technology transfers. However, it is also possible that it accounts for firms' relocation of dirty activities that is not fully captured by the control variables.

As expected, the coefficient for trust is negative and statistically significant. An estimate of –0.24 implies that a change of 1 percent in trust (i.e. one percent of respondents switching from the answer "You cannot be too careful in dealing with other people" to the option "Most people can be trusted") leads to a decline in per capita greenhouse gas emissions of 0.24%[11]. The magnitude of the effect related to trust seems considerably large for a variable that was neglected until very recently and thus justifies its inclusion as a determinant of greenhouse gas emissions.

The coefficient for trust is however not robust to the inclusion of energy consumption. That is, in model (2), which adds energy consumption, the coefficient for trust becomes non-significant, as shown by column (3). This result supports our previous discussion, since we expect trust to decrease energy consumption both directly and indirectly. Regarding the coefficient for energy, its sign is in line with expectations, as well as the boost in the goodness of fit. The estimate of column (3) implies that for one percent increase in energy consumption, emissions increase by 0.8%, which makes sense since not all energy sources are related to all greenhouse gases in the same way. We also see that all control variables are stable to the inclusion of energy consumption, which is positive sign of robustness. The exception is GDP per capita, which turns out to be negative. However, this comes as no surprise, since the scale effect is likely to be captured by the coefficient of energy consumption, which controls for the dirty component of economic growth.

The last step for testing mediation consists in estimating the impact of trust on energy consumption. Estimates for model (3) are shown by column (4). We find that trust does indeed affect energy consumption, and with a negative sign. The coefficient of -0.32 implies that a one percent increase in the level of trust would lead to a reduction in energy consumption of about 0.3%. Control variables behave very similarly to model (1). Indeed, a larger share of manufacturing is related with larger energy consumption, as well as GDP per capita. Abstracting from issues of endogeneity, which are not crucial while dealing with controls, column (4) would suggest that economic growth is responsible for larger energy consumption, thus supporting the positive coefficient on emissions. The coefficient for trade becomes instead non-significant. Interestingly, it may imply that trade does not affect emissions through the level of energy consumption

[11] This figure is robust to the addition of a time trend or time dummies. Results available upon request.

but through its content (i.e. the energy-mix), which may support the technique effect.

Altogether, Table 1.1 provides evidence in favor of the role of energy consumption as mediator. Results also rule out the mediation of the energy-mix, or of non-energy emissions. However, we take them as evidence that the largest effect goes through the level of energy consumption and not through its content, rather than as a case of perfect mediation. We also perform some additional mediation regressions with a series of variables proxying technology or the energy-mix, e.g. patents, dirty sources such as coal and oil, share of renewable energy, share of nuclear energy (cf. Roca et al. 2001, Buehn and Farzanegan 2013)[12]. Still, the coefficient for trust is not affected. Hence, we conclude that we fail to find evidence on the role of the energy-mix as mediator.

Since it is possible that trust has a delayed impact on emissions, we account for a non-simultaneous relationship by introducing lags between trust and emissions per capita. We expect that the influence of trust decreases with time and we are interested to know how long the "memory" is influencing emissions. We find however that including lags do not substantially improve our model (results not reported here). We estimate an optimal lag for each time series (i.e. for each country i) with a sufficient number of observations, borrowing from the tools of vector autoregression (VAR) analysis. Only in a minority of cases the optimal lag exceeds the fourth lag. However, autocorrelation is still present even at the fourth lag, according to a Lagrange-multiplier test. Hence, we prefer to rely on the contemporaneous model presented here.

As discussed in Section 1.2, the impact of trust on energy consumption and thus emissions may cumulate the impact on individual behavior and environmental policy (paths A and B). Obviously, we would have preferred to disentangle the two effects, e.g. by isolating the role of environmental policy. However, environmental policy is very difficult to measure and proxies hardly capture the panoply of possible local and national efforts. Yet, we consider some indicators for domestic and international policy (i.e. top-down initiatives) such as Eurostat's total environmental tax revenue and the policy components of the Climate Change Cooperation Index (C3-I) and of the Climate Change Performance Index[13]. Unfortunately, the overlap between our panel and the

[12] All variables come from Eurostat. "Patents" stands for patents applications to the European Patent Office. Results available upon request.

[13] "Total environmental tax revenue" is available e.g. as a percentage of GDP (cf. Costantini and Mazzanti 2012). The C3-I is developed by Bernauer and Boehmelt (2013) and updates the Cooperation Index of Baettig et al. (2008). The C3-I's policy component evaluates the efforts of a country for the success of international negotiations, by giving marks based on commitments to the United Nations Framework on Climate Change (UNFCCC), ratification of the Kyoto Protocol, emissions reporting and contributions to finance the UNFCCC structure. Instead, the policy component of the Climate Change Performance Index, released by Germanwatch, is based on local climate change experts' opinions. The C3-I goes back until 1997 and encompasses 172 countries, whereas the Climate Change Performance Index delivers reliable policy evaluation starting from 2006 (available in the index of 2007, cf. Burck and Bals 2012).

latter is too short for obtaining any meaningful result. Instead, we are able to test for mediation with the remaining indicators. Although we find a negative effect of both environmental taxation and the C3-I on the level of energy consumption, the coefficient for trust is unaffected. In addition, the estimate for the C3-I does not reach statistical significance. This evidence does not play in favor of the policy channel, but this may be due to the variables used, which are only rough proxys for the sum of local, regional and national efforts towards curbing energy consumption and reducing greenhouse gas emissions.

Hence, we look back to the WVS and examine the relationship between trust and collective action as expressed by the following two questions: "Would give part of my income for the environment" and "Increase in taxes if used to prevent environmental pollution". In both cases the possible answers are: "Strongly agree", "Agree", "Disagree" and "Strongly disagree". 125 observations are available for the first question (out of 35, by interpolation). If we take the share of people answering "Strongly agree" and "Agree" to the first question, the correlation with "Trust most people" is positive (0.23) and significant (at 1%). Regressing "Give part of income" on GDP per capita, the time trend, fixed effects and trust leads to a positive coefficient for trust of 0.792, significant at 1%. This suggests that an increase of trust by 1% leads to an increase of about 0.8% of people accepting to forsake part of their income to help the environment. For the question on environmental taxation, we find a correlation of 0.29 with trust, significant at 1% (based on 192 observations out of 54). By regressing "Increase in taxes if used to prevent environmental pollution" on income per capita, existing levels of environmental taxation, the time trend, fixed effects and trust, we find a coefficient for trust of 0.581, statistically significant at 1%. This coefficient implies that a change of 1% in trust leads to 0.6% increase in people strongly agreeing or agreeing to increase taxes used for environmental purposes. Arguably, it implies being ready to give up part of their income. However, the correlation between "Give part of income for the environment" and "Increase in taxes" is of "only" 0.7, leaving room for direct pro-environmental behavior. Given the small set of observations and the previous discussion, we take these findings as descriptive evidence supporting the case for further analyses on the policy channel. That is, we leave for future studies the task to measure the contribution of each of the two channels, as well as the net impact on emissions (including the trust-to-growth effect). Indeed, we recall that because we control for GDP per capita in the econometric framework, we do not provide a full picture on the role of trust as a determinant of emissions through not only individual behavior and policy, but also economic growth. In addition, one may see as appropriate to include

trust in foreign people in the analysis of the policy channel.

Another avenue for future research would consist in analyzing how societies can address the issue of trust and foster the level of cooperation among individuals. Some recent works convey converging evidence emphasizing the need to target the "push factors" determining environmental behavior through normative discourses (e.g. by exhibiting the neighbors' level of cooperation), attempting to stimulate agent's trust in a shared effort toward climate change mitigation (see e.g. Cialdini 2003; Schultz et al. 2007; Steg and Vlek 2009; von Borgstede et al. 2013; Lindman et al. 2013). More in general, reducing inequalities, improving institutional quality and enhancing education (especially teaching cooperation) should contribute in building trust (Knack and Keefer 1997; Zak and Knack 2001). Given that these are major tasks, from a policy and governance perspective it may thus be important to start by using the existing trust networks (see Catney et al. 2013a) and overcome the social barriers hampering the emergence of new ones (Catney et al. 2013b). Both policymakers and practitioners may look with interest at the recent evidence showing how, for instance, green technologies such as solar photovoltaic systems spread over neighborhoods through social interaction, as shown by Bollinger and Gillingham (2012; see also Currarini et al. 2014 for a discussion). Finally, improving the quality, quantity and understanding of data on trust (and on social norms more in general, pro-environmental behavior, environmental collective action and environmental policy) would allow for a substantial advancement in this research area. Indeed, we recall the limits of our measure of trust and agree with Glaeser et al. (2000) that measurement and interpretation of trust represent an important lacuna of the research fields relying upon this variable. For instance, further experimental evidence in the same spirit of Glaeser et al. (2000) may help to elucidate the microeconomic mechanisms analyzed here in their aggregated form. The availability and possibility to apply instrumental variables may also contribute to perfecting the structural model underlying the regressions and provide causation rather than correlation.

1.5 Conclusion

Recent contributions in the theory of collective action have shown that predicted non-cooperative attitudes in social dilemmas sometimes fail to be verified in empirics. This fact is supportive of the new strand of research highlighting the importance of social norms and social contextualization for understanding collective action. However, until recently, social aspects of economic behavior related with environmental goods were

confined to local issues. Elinor Ostrom eventually extended the concept revealing the extent of grassroots projects tackling climate change from different perspectives. This phenomenon was in the public eye, but an important contribution was necessary to realize what has then become evident: struggling international negotiations are only a side of the coin of climate change mitigation. Ostrom (2009) explains the willingness of many citizens to provide collective efforts to curb emissions as a result of trust among them, broadening the trust-and-reciprocation mechanism of commons.

We apply her insights and test for an aggregated effect of trust on greenhouse gas emissions and offer evidence in favor of the Ostrom Hypothesis. Indeed, we find a negative effect of trust on emissions, based on a panel of 29 European countries over the period 1990-2007. The estimated negative elasticity would imply that a one percent increase in trust would reduce emissions of 0.24%, by leading to a decline in energy consumption of about 0.32%.

The correlation between trust and growth (Knack and Keefer 1997; Zak and Knack 2001) and the nexus we find from trust to emissions may explain why some economists attempted to link income growth with emissions in a non-linear way. In our opinion, trust and social values may contribute to answer to Esty and Porter's (2005) quest for an explanation beyond the Environmental Kuznets Curve regarding cross-country differences in environmental pressures. Hence, not accounting for trust would lead to an omitted variable bias attributing to other variables, e.g. income per capita, the effect of trust and social values.

In conclusion, we agree with Elinor Ostrom and co-authors with the need of a paradigm shift in the way environmental issues are analyzed from an economic perspective and in the choice of the relevant factors to be considered.

Several caveats limit the interpretation of our results beyond their context and create the bases for further research. First, we use an imperfect measure of trust, which is collected only occasionally. Second, we provide an aggregated result, but we are not able to disentangle the ways that lead trust to be effective in reducing emissions. Third, we do not assess the net effect of trust, which should encompass also the growth-driven impact on emissions. Fourth, it is still largely unexplained how policymakers can act on and upon trust and social values, although some reviewed contributions started to target the issue.

Chapter 2

Paying enough taxes already? Testing the acceptability of carbon taxes with survey data[1]

This paper analyzes the drivers of carbon taxes acceptability with survey data and semi-experimental techniques. Based on a sample of more than 300 individuals, it assesses the effect on acceptability of specific policy designs and individual's perceptions of carbon taxes advantages and disadvantages. We find that the lack of perception of primary and ancillary benefits is one of the main barriers to the acceptability of carbon taxes. We also show that policy design matters for acceptability and in particular that earmarking fiscal revenues for environmental purposes can lead to larger support. We also find an effect of labeling, comparing the wording "climate contribution" with "carbon tax". We argue that proper policy design coupled with effective communication on the effects of carbon taxes may lead to a substantial improvement in acceptability.

2.1 Introduction

In recent decades, international negotiations have aimed at stabilizing the concentration of greenhouse gases at levels that would prevent dangerous interferences with the climate system. However, there is increasing evidence showing that current mitigation

[1]Chapter written with Andrea Baranzini as part of the project "Social cushioning of energy price increases and public acceptability" (SEPIA), sponsored by the Swiss Federal Office of Energy. Comments from Boris Krey, Philippe Thalmann, Frédéric Varone and Frank Vöhringer really contributed to improve this paper. I thank as well seminar audience at ETH Zurich and participants to the Workshop on Economics of Energy Efficiency, Reus, the 6th Atlantic Workshop on Energy and Environmental Economics, A Toxa, the biennial conference of the International Society for Ecological Economics, Reykjavík, and the 15th Global Conference on Environmental Taxation, Copenhagen. Working paper version available as Carattini and Baranzini (2014).

efforts are by large not enough (UNEP 2013; IPCC 2014). This result comes as no surprise. Even though economists assessed their theoretical cost-effectiveness long time ago (cf. e.g. Baumol and Oates 1971), the implementation of powerful policy instruments to reduce greenhouse gas emissions such as carbon taxes is a rather recent phenomenon (Baranzini and Carattini 2014). A recent strand of literature has started exploring the public acceptability of carbon taxes, pointing to a series of important obstacles such as distributional impacts on low-income households and fear of competitiveness effects (cf. Baranzini et al. 2000; Zhang and Baranzini 2004). In most developed countries carbon taxes are indeed at least slightly regressive (see e.g. Roca and Serrano 2007; Brännlund and Ghalwash 2008; Sterner 2011) and the local co-benefits benefitting mostly the poorest households are usually given a lower weight. Despite the recent empirical evidence points to rather small competitiveness effects (Mathys and de Melo 2011), potential adverse effects on employment and competitiveness represented a real concern when the first carbon taxes in Scandinavian countries were designed (cf. e.g. Godal and Holtsmark 2001; Bruvoll and Larsen 2004) and when similar schemes were turned down elsewhere (cf. e.g. Thalmann 2004).

More recently, the literature has devoted increasing attention towards the perceived impact of carbon taxes on the environment. While economists tend to take the beneficial environmental effects as granted, the effectiveness of carbon taxes does not seem to be internalized by the general public. Based on qualitative assessments, Dresner et al. (2006) first raised the issue of perceived environmental ineffectiveness: the general public tends to miss the incentive effect of carbon taxes, thus expecting tax revenues to be earmarked for environmental purposes. When this is not the case, most people feel that carbon taxes are just a pretext to raise new fiscal revenues. When tax revenues are earmarked for other purposes, the general public is generally disconcerted about the possibility of using the revenues of an environmental tax for something unrelated to the environment. Sælen and Kallbekken (2011) define this problem as "issue-linkage". The stylized fact of Dresner et al. (2006) is supported by the quantitative evidence of Kallbekken and Sælen (2011) and Sælen and Kallbekken (2011), both finding a negative pattern between perceived environmental ineffectiveness and stated support for carbon and energy taxes, and is consistent with real voting behavior as analyzed by Thalmann (2004). Environmental taxes are thus perceived at the same time as coercive and ineffective (Steg et al. 2006). This may lead environmental taxes to be more popular if not labelled as such: in the lab experiment of Kallbekken et al. (2011), a "fee" is preferred to an equivalent instrument called "tax".

We improve this recent literature by using survey data and semi-experimental tech-

niques to test the effect of several policy variables and perceptions on acceptability. First, we confirm that perceived environmental ineffectiveness is one of the main barriers to the acceptability of carbon taxes. In this respect, our original approach shows that not only the expectation of main environmental effects affects acceptability, but also the perception of potential co-benefits does. Second, we show that competitiveness and distributional effects do not have a role as determinant of acceptability. While most individuals express a concern for distributional effects, this concern does not affect the choice of whether supporting or not carbon taxes. Competitiveness effects do not even reach the status of general concern, in spite of the common rhetoric. Hence, policymakers may not face a clear trade-off between environmental, distributional and competitiveness effects. Third, we show that acceptability increases substantially with earmarking, in particular for environmental purposes. People trusting the government are more likely to accept a carbon tax when no earmarking is specified, whereas people not trusting the government are more likely to do it when earmarking is clearly defined. However, earmarking does not act as a substitute for perceived effectiveness. Even when revenues are earmarked, perceived effectiveness remains related to higher acceptability. Fourth, contrasting the labels "carbon tax" and "climate contribution", we show that labelling can spur acceptability also in the street and not only in the lab. "Climate contribution" may sound as an appeal to the public good, recalling to the general public the urgency of climate change mitigation.

We use the Canton of Geneva, Switzerland, as field and interview more than 300 individuals between December 2012 and January 2013. The Swiss context may be particularly salient to simulate voting behavior, since Swiss people are used to express their opinions in poll and ballots, but we consider all of our findings of general interest. The lack of popularity of carbon taxes has indeed limited its implementation in virtually all political contexts in developed countries.

2.2 Survey design and data description

2.2.1 Hypotheses

Following the discussion in the Introduction, we formulate a series of main hypotheses to be tested with the econometric model.

We expect positive (negative) perceived impacts of carbon taxes to be positively (negatively) associated to carbon tax acceptability. Positive impacts consist in carbon emissions abatements (i.e. environmental effectiveness) and improvements in local out-

comes such as air quality, health and road externalities. As shown by Dresner et al. (2006) and Bristow et al. (2010), the acceptability of a given carbon tax design can be influenced by how agents perceive the instrument as effective. Brouwer et al. (2008) also find a significant and positive impact on acceptability when a hypothetical carbon travel tax is perceived as effective. We are not aware of previous studies examining the link between perceived co-benefits and acceptability, but the willingness-to-pay literature suggests that the willingness-to-pay for climate change mitigation is about 50%-70% higher when co-benefits are considered by respondents (Longo et al. 2012).

Concerning drawbacks, distributional concerns are shown to affect acceptability in Thalmann (2004), wherein the probability of a yes-vote for a green proposal is substantially lower for those bills implying a clear increase in inequalities, and in Bristow et al. (2010), whose data show a marked preference for a carbon credit up to 4 tons of CO_2 per capita to reduce distributional effects. Inequality aversion is also present in Kallbekken and Sælen (2011) and Brannlund and Persson (2012).

Acceptability is supposed to increase with earmarking and we expect earmarking for environmental purposes to contribute the most (cf. e.g. Dresner et al. 2006; Steg et al. 2006; Kallbekken and Aasen 2010; Sælen and Kallbekken 2011). When earmarking is not specified, we expect people distrusting the government to be less likely to approve carbon taxes. This is again related with perceived environmental ineffectiveness. Most people fail to understand the difference between Pigouvian and Ramsey taxes and perceive environmental taxes as a mean to raise more revenues (Kallbekken et al. 2011). Hence, people may be willing to give up some of their income only if the use of revenues is clearly made explicit. This is, for them, the only way to impact the environment.

Based on the literature, we also forecast higher acceptability in the climate-contribution subsample as compared to the carbon-tax subsample. According to Steg et al. (2006), environmental taxes are perceived by most of the general public as "penalties", i.e. coercive measures imposing a change in behavior. Higher acceptability with different labeling is found not only in Kallbekken et al. (2011), but also in the online choice experiment of Brannlund and Persson (2012), in which a policy called "tax" is opposed to another policy simply framed as "other". To make the contrast even more manifest, we opt for "climate contribution" as opposed to "tax". We expect "climate contribution" to sound as an appeal to the public good, which may crowd in motivation as predicted by persuasive advertising models as in Becker and Murphy (1993) and Nyborg et al. (2006). "Climate contribution" may signal that the climate as we know it (i.e. the status-quo) requires help, whereas a "tax" may recall a threat to disposable income (cf. e.g. Kahneman and Tversky 2000).

Finally, we recall that most of the general public would not tackle climate change as economists would, i.e. with "first-best" economic instruments. Indeed, "non-coercive" policies enjoy much higher acceptability. Hence, people not considering carbon taxes as a priority to cope with climate change are expected to be less supportive of this instrument and the other way round. In sum, the hypotheses that we test in sections 2.3.1 and 2.3.2 are the following:

H1 Perceived positive (negative) effects of carbon taxes positively (negatively) affect carbon tax acceptability. Positive effects consist not only in emissions abatements but also of local co-benefits.

H2 Earmarking revenues increases acceptability, especially for environmental purposes.

H3 The support to carbon taxes of people not trusting the government is especially dependent on the use of revenues.

H4 The label "climate contribution", as opposed to "carbon tax", generates more support.

H5 Most people do not see carbon taxes as the main solution to curb greenhouse gas emissions. These people are less likely to support carbon taxes.

To test these hypotheses, we administer a questionnaire pre-tested and supported by a qualitative study (see section 2.2.3) to random people approached in the streets of Geneva for face-to-face interviews. In an experimental spirit, we test for hypothesis H4 by administering two types of questionnaire: at random, half of the sample received a questionnaire with the wording "carbon tax" (hereafter CT), while the remaining with "climate contribution" (CC)[2].

2.2.2 Economic context

From a climate policy perspective, the context of Switzerland is of particular interest. Switzerland lobbies beside the European Union in the post-Kyoto negotiations, urging for ambitious agreements. In addition, in the aftermath of the Fukushima accident, Switzerland decided to start to phase-out nuclear energy. Since currently 40% of electricity is from nuclear sources, Switzerland has very low carbon emissions from electricity in international comparison and thus little room for maneuver to replace nuclear energy without increasing carbon emissions. This implies the need for substantial reductions in consumption (Baranzini et al. 2013).

[2]Cf. Appendix B for the full questionnaires.

Given the public rejection of three energy-tax proposals in 2000, Switzerland adopted a climate strategy based on voluntary agreements and only in 2008 introduced a carbon tax limited to heating fuels (cf. Thalmann 2004; Baranzini et al. 2004). After that Switzerland in 2012 missed its objective of CO_2 emissions reduction, the carbon tax rate was revised upward, but an extension of the tax base to all fuels may be desirable to reach the more ambitious abatement targets currently under consideration[3]. In particular we refer to the pledge that Switzerland submitted to the UNFCCC in February 2015 in view of the same year's Conference of Parties, consisting in a reduction of emissions of 50% by 2030 with respect to the levels of 1990. Doing so, Switzerland became the first country to submit a pledge and set the bar high for the following participants.

Energy taxes are already a hot topic in Switzerland. In March 2015, the Swiss population rejected at 92% (90.9% in the Canton of Geneva) an extremely ambitious popular initiative promoted by the Green Liberals aiming at completely replacing the current value-added tax (VAT) with an energy tax. Given the substantial dependence of the Swiss government from VAT revenues and the concern that energy prices would have spiked well beyond what currently under consideration by policymakers, the promoters of the initiative found themselves practically isolated and with the government taking position against the initiative. While the Swiss government opposed the specific proposal brought up by the Green Liberals, it does support the principle of economic incentives and in particular of generalized carbon taxes. Shortly after the vote, the Swiss government announced its plan for reaching the abovementioned targets, which indeed relies on carbon taxation of all fuels (with a short embargo on gasoline) and lump-sum redistribution of revenues. In line with the findings of this paper, the Swiss government interprets the March 2015's vote as a rejection of the Green Liberals' proposal and not of carbon taxes *per se*.

2.2.3 Qualitative survey

To define the questions of the quantitative survey, we first administer through semi-structured interviews a qualitative survey to a small and unrepresentative sample of about 40 adults living in the Canton of Geneva. Methodology and detailed results are presented in Baranzini et al. (2014). Here, we report the main findings. First, private actions (e.g. improvements in energy efficiency) are preferred to public intervention to curb energy consumption and emissions. Second, when interviewers introduce ex-

[3]The current tax rate is 60 CHF per ton of CO_2, but the government can increase it up to 120 CHF/tCO_2 if deemed necessary. As of May 2015, 1 CHF $\approx$ 1.05 USD $\approx$ 0.95 EUR. Two thirds of revenues are redistributed lump sum to households and through lower social contributions to firms. The remaining third is allocated to energy-efficiency investments in the building sector.

plicitly the role of the public sector, the general opinion is to limit its intervention to communication and education (i.e. suasion). Market instruments are mentioned only by few, and subsidies (e.g. for public transportation) are by large preferred to taxes, as in Cherry et al. (2012).

Third, interviewers face some resistance when they propose the implementation of a generalized carbon tax, related to distrust in the government and a presumed ineffectiveness in changing behavior. It follows that when they ask how tax revenues should be used, most respondents suggest to keep them in the environmental domain. Fourth, social cushioning for low-income households is regarded as important, but it seems that the way of financing it should make abstraction of environmental tax revenues.

2.2.4 Quantitative survey

2.2.4.1 Sample properties

Our sample is composed of 338 valid observations, 158 in the CT and 180 in the CC subsamples. The composition of the sample is fairly representative of Geneva population, except for a slight under- (over-)representation of retired (young) and low-educated individuals. Based on the socioeconomic characteristics of Table B.1, we compare the CT and CC sub-samples. We do not find any statistical differences in the averages of these variables, except in the case of education (16 years with CT compared to 15.59 with CC) and the number of adults in the households (2.15 with CT and 2.44 with CC). Even though most of our insights are driven by internal validity, we are also concerned by the external validity of our results. The econometric approach of section 2.3 takes thus care of possible sample selection.

The survey also identifies members of environmental organizations (hereafter "green members", 14% of the sample) and political positioning (coded as left, center, right and no positioning), and investigates general measures of self-reported environmental concern. It also asks whether respondents generally trust their government (93%) and if they are aware of the existing CO_2 tax on heating fuels (only 40%). The lack of awareness concerning current taxation may be explained by the limited salience of both taxation and lump-sum refund to households through reduced healthcare bills. Respondents are also asked what role they would attribute to the public sector to spur energy conservation. Only a tiny fraction of individuals (2%) contends that there is no need for energy conservation at all. Similarly, only 3% believe that energy consumption does not need to be regulated. That is, the large majority expects the government to intervene to curb energy consumption. However, as for the qualitative survey, market

instruments do not represent the favored tool. Preferences go rather to informational campaigns raising awareness and to policies funding public transportation. Our survey thus anticipated to some extent the results of the ballot of February 9th 2014, when a credit of 6.4 billion to fund public transport infrastructures was accepted by the Swiss population with 62% of yes-votes (participation at 55%). However, already at this stage 35% of respondents believe that the Swiss government should intervene with a broader carbon tax to lower energy consumption.

2.2.4.2 Policy variables

In what follows we present the main policy variables included in the survey (cf. Table B.3 for the full descriptive statistics).

Carbon taxes' environmental effectiveness In the survey we introduce a hypothetical carbon tax (or climate contribution) with a tax rate of 120 CHF per ton of CO_2, implying a price increase of gasoline of about 15% and of heating fuel of about 30%. The majority of the sample thinks that the tax would lead to a reduction of their level of energy consumption, but a non-negligible proportion of respondents (37%) expects no change in behavior. A small minority (7%) even expects larger consumption. These either represent protest answers or suggest that worries of a possible motivational crowding-out may be justified. That is, economic instruments and financial compensations may turn out to have counterproductive effects on intrinsically-motivated agents (Deci and Ryan 1985), if individuals that already provide large efforts for a given public good in absence of any economic incentive feel frustrated for being taxed despite their efforts ("no behavior is good enough not to be penalized", Goeschl and Perino 2012) or feel less responsible toward the provision of the public good as they think that "since I pay, I can consume and thus pollute" (Bazin et al. 2004).

Next, the questionnaire enlarges the focus and asks whether people expect the tax to be effective, i.e. if it would lead to a decrease in the energy consumption and greenhouse gas emissions of Switzerland. A short majority (52%) expects the tax not to be effective.

Co-benefits Respondents are asked to spontaneously mention a list of ancillary benefits of carbon taxes, if any, without having access to the list of potential answers in the questionnaire, to avoid to influence their opinions. About half of the sample (56%) expects better air quality as an ancillary benefit from carbon taxes. The proportion is lower for congestion issues (27%), health improvements (42%) and road accidents

(18%). People thus exhibit a relatively low awareness of co-benefits, which may need to be targeted through improved communication, along with primary benefits.

Disadvantages In line with the literature, regressive effects seem to represent a real issue for the people in this sample. However, we find that only a minority (25%) is concerned about distributional effects on rural households, which are also expected to be particularly affected, given the limited possibilities of substitution between private and public transportation in the countryside. This may be specific to the context of Geneva, whose countryside hosts many high-income households attracted by calmness, green spaces and possibly interesting fiscal conditions. Instead, only relatively small proportions of respondents are concerned about employment and competitiveness effects. In particular, the number of people concerned about unemployment issues (11%) is only slightly larger than those concerned about their own job (5%, correlation of 0.46). We note that at the time of the survey the level of unemployment in the Canton of Geneva (in Switzerland) was about 5.5% (3%).

Finally, one of the main perceived drawbacks is represented by the private cost of climate change mitigation, which is strictly positive for all citizens absent any earmarking. The most generalized fear for respondents in this sample (67%) is to be constrained to reduce the overall level of consumption due to the higher energy prices. Interestingly, expecting lower purchasing power does not necessarily imply a loss of comfort. It appears that people in the sample feel that they could live comfortably even with less purchasing power, although they may not like it. Further data inspections show that expecting losses of purchasing power is negatively correlated with the highest income category and expecting less comfort is positively associated with the lowest income category.

Acceptability After discussing policy's advantages and disadvantages, we directly test for policy acceptability. No earmarking is specified at this stage, i.e. tax revenues fund the general budget, which is supposed to be the first best from an economic perspective (cf. Sælen and Kallbekken 2011). The share of positive answers is quite high and close to majority (49%). In fact, the approval rate is very close to the support given to the "Energy conservation package" in the ballot of 2000 (46.6%, cf. Thalmann 2004)[4].

[4]Respondents were also given a "Do not know" option. However, what we want to assess is the willingness to accept such a policy and hence treat irresolute respondents as no-voters, although abstention is always an alternative in ballots. 93 individuals are concerned.

Social cushioning The questionnaire then asks what groups of population should be compensated due to the CT/CC perceived adverse impacts. Social cushioning is particularly warranted for low-income households (72% of support), but around 50%-60% of respondents support also compensating measures for elderly people and large families. We stress that retiring implies lower income (60% of pre-retirement income is the social security target in Switzerland) and pensions are not indexed to inflation. In the United Kingdom, for instance, lump-sum transfers are done in favor of people aged 62 or more under the Winter Fuel Payment scheme. Probably administratively burdensome, cushioning of these two categories is however seldom mentioned in the literature.

Societywide refunds, i.e. the current way of refunding tax revenues from the Swiss carbon tax on heating fuels, seems not to be the preferred option for our sample, although it represents a simple and cheap (but also possibly ununderstood) way of reducing regressivity (see e.g. Metcalf 2009; cf. Pezzey and Jotzo 2013 and Bristow et al. 2010 on tax thresholds). In particular, we remark that older people are disadvantaged by the current recycling, while Table B.3 would rather justify a specific aid to this sub-population.

Revenue recycling We propose three ways of revenue recycling (and give space for a possible fourth option). The first option is redistribution towards affected households, which relates to the previous discussion on distributional effects. The second option consists in tax rebates for households and firms, which may allow, by decreasing distortionary taxes, for the double dividend of environmental taxation. Earmarking tax revenues for environmental purposes is a recurrent and popular option in the literature and represents the third alternative. Respondents are asked to rank the alternatives in decreasing order of preference. Unsurprisingly, 60% of the respondents would like to see the tax revenues used to finance environmental projects. Social cushioning comes second, while tax rebates to households and firms are supported by a small minority only.

Acceptability conditional on recycling We retest the level of acceptability conditional on earmarking and revenue recycling. In detail, the survey asks whether the respondent would accept a CT/CC if revenues were to be recycled according to her preferred recycling option. Yes-votes reach now 64%, i.e. about 15% more than without earmarking. This result is consistent with the literature. This level of support may however be misleading since obtained by assuming that the preferred recycling op-

tions of each individual can be implemented simultaneously. We also stress the relative importance of the residual 36% of respondents for which earmarking revenues is not sufficient to have them accepting the CT/CC, at least at the tax rate proposed by the questionnaire. Econometric analyses are performed in section 2.3.

Tax rate So far, the questionnaire refers to a CT/CC with a tax rate of 120 CHF/tCO_2, causing with full pass-through an increase of about 15% (30%) in the price of gasoline (heating fuels). The questionnaire thus asks to the respondents what would be their highest acceptable CT/CC tax rate, expressed in terms of energy price increases. The aim is to measure the intensity of acceptability. The distribution of answers is bounded by the minimum and maximum possible answers given in the questionnaire (0% and 30%) and centered in the 5%-10% interval (using interval means, the average is 7% and the median 7.5%). Hence, albeit 64% of the sample supports the tax in the previous question, when asked about defining themselves the tax rate, respondents tend to indicate more moderate energy price increases than what proposed by the survey. The two results are not necessarily in contradiction. Voters are indeed supposed to select the option that is closer to their preferences. In this respect, the Norwegian choice experiment of Sælen and Kallbekken (2011) shows that respondents would prefer to decrease the current level of environmental taxes, absent earmarking for environmental purposes. In a similar spirit, Godal and Holtsmark (2001) suggest to always start with a low tax rate and increase it regularly once the policy is in place.

2.3 Econometric analysis, results and discussion

2.3.1 Carbon tax acceptability

In this section we analyze the determinants of carbon tax acceptability when earmarking is not specified. Since the outcome variable is binary, we apply a probit estimation strategy. Model (1) estimates the effect of a vector of independent variables x on the probability of accepting the carbon tax (or the climate contribution). From Greene (2011):

$$Prob(Acceptability = 1|x) = F(x, \beta) \tag{2.1}$$

with equation (1) including both continuous (e.g. number of cars) and dummy variables (e.g. green membership). In general, the marginal (or partial) effect is given by:

$$Marginal\,effect = \frac{\partial F(.)}{\partial x} \tag{2.2}$$

which is obtained by multiplying β for the normal density. That is, $f(x'\hat{\beta})\hat{\beta} = \hat{f}\hat{\beta}$. For dummy variables, the change is discrete. Hence, the partial effect of a dummy d is given as:

$$Marginal\,effect = Prob(Acceptability = 1|\bar{x}_{(d)}, d = 1) - Prob(Acceptability = 1|\bar{x}_{(d)}, d = 0) \tag{2.3}$$

where $\bar{x}_{(d)}$ is the mean of all variables but *d*. We use as controls both socioeconomic characteristics and the policy perceptions presented in the previous section. Several socioeconomic factors are possible determinants of the demand for environmental policy in general and climate change mitigation in particular. We obtain from our survey data on e.g. income, education, age, gender, car holding (as proxy for carbon footprint, see Thalmann 2004; Kallbekken and Sælen 2011; Diederich and Goeschl 2013) and membership of environmental organizations (as proxy for pro-environmental behavior).

Estimations results are reported in Table 2.1, based on marginal effects at median, consistently with the median voter theorem[5]. Column (1) starts with socioeconomic characteristics.

Given the many missing values and its statistical non-significance, income is excluded rather than manually imputed. A variable taking value 1 if income is missing would also be non-significant. The absence of an effect of income is in line with the literature on environmental ballots (see e.g. Deacon and Shapiro 1975; Thalmann 2004; Bornstein and Lanz 2008) and fits the theoretical prediction, above all in a global context in which the demand for environmental quality is likely to be only partially expressed (cf. Roca 2003). A priori, the effect of income on the acceptability of carbon taxes is indeed ambiguous. Three main channels relate income with preferences for climate change mitigation. First, if the environment is a normal good, the higher the income, the larger the demand for environmental quality. Second, slight regressivity as discussed in section 2.1 implies that richer individuals are likely to consume less (more) energy in relative (absolute) terms and thus climate policy would impose on them a lower

[5]Marginal effects are derivatives computed in different ways depending on the assumed underlying distribution. Probit assumes a normal (Gaussian) distribution for *F*. We compare marginal effects at median with marginal effect at mean, average marginal effects, logit (which allows for "thicker tails") and OLS. Marginal effects at mean and average marginal effects are qualitatively unchanged with respect to the estimates presented in Table 2.1 (estimates not provided here). We find that for most coefficients the choice of the econometric model has implications for the interpretation in terms of magnitude, but not of sign and significance. In the logit model co-benefits turn out to be non-significant. The same applies for OLS. Given the presence of heteroscedasticity, the estimated model includes a heteroscedastic error term ϵ_i. Standard errors are computed with the Delta method (cf. Greene 2011). We report estimations for our preferred models, but the insights provided in this section generally hold also with different specifications.

(higher) relative (absolute) burden. Third, local environmental improvements may favor relatively more low-income households, but any effect on acceptability requires individuals to be informed about local co-benefits.

Some other socioeconomic variables are clearly not significant. We do not find for instance any statistically significant effect for age (both as a continuous variable or using specific groups such as e.g. youth, retired people), gender and political positioning.

Column (1) shows that the number of cars held by respondents is negatively and significantly linked with the probability of accepting a carbon tax, whereas green membership and education have a positive impact. That is, as in Thalmann (2004), it is not only car ownership, but the number of vehicles that is related to political behavior. Ecologists are of course expected to be relatively more in favor of climate policy tightening, assuming no motivational crowding-out. The effect of education is also as predicted. Since education is a long-run investment, educated people may possess a lower discount rate than the average citizen, according to Bornstein and Lanz (2008). Moreover, educated people may suffer of lower informational gaps on climate change issues. Lack of information could downplay the relative benefits of climate change mitigation (cf. e.g. Cohen and Viscusi 2012)[6]. The coefficient of column (1) implies that an additional year of education is linked with about 3% more probability of accepting the tax, thus mirroring the evidence on ballots (cf. Thalmann 2004; Sciarini et al. 2007; Bornstein and Lanz 2008; Bornstein and Thalmann 2008; Stadelmann-Steffen 2011) and on the demand for climate change mitigation (see e.g. Roe et al. 2001; Achtnicht 2012; Löschel et al. 2013).

In column (2) we introduce variables on environmental attitudes. This allows us to test the hypotheses H3 and H5. We find that being a priori in favor of a carbon tax has a very large effect on acceptability. This confirms H5 and provides evidence for the internal validity in the questionnaire. As expected, trust in the government engenders higher acceptability, providing first evidence in favor of H3.

We also find that being highly concerned about the climate and paying no attention to energy consumption have a significant and economically meaningful impact on acceptability, consistently with Kallbekken and Sælen (2011). Since the effect of education disappears once introduced the role of information and concern, we may suggest that its effect is rather driven by information asymmetry than a difference in discounting. Expectation of cooperation in energy conservation's efforts from fellow-citizens is

[6]Note however that increasing information may instead reinforce existing beliefs leading to a polarized society (Kahan et al. 2011). Individuals may also be well informed but still skeptical if they do not trust the information source, e.g. the government (Ricci et al. 2010).

associated with a positive effect on acceptability. We relate this finding with the recent works in the theory of collective action arguing that cooperation may work similarly in global and local dilemmas (see e.g. Owen and Videras 2008; Ostrom 2009 and Chapter 1 of this thesis).

Column (3) introduces the policy variables. The coefficients of column (2) are generally robust to this new specification. "Government: information" now reaches significance, suggesting the perception of a complementarity between information and taxation. According to the focus group of Kallbekken and Aasen (2010), the general public feels that information campaigns should accompany the implementation of climate policy providing knowledge on its instruments and not only raising awareness on climate change (see also Nyborg et al. 2006; Brannlund and Persson 2012).

Column (3) allows us to further test our main hypotheses. The effects related with environmental effectiveness and perceived co-benefits are striking and partly confirm H1. If the tax is expected to be effective in reducing emissions, acceptability rises by about 30%. The impact of co-benefits on acceptability has a similar magnitude, since this variable ranges from 0 to 8. Hence, our findings strongly support the literature on the role of perceived effectiveness and provide a quantitative estimate of its effect on acceptability, which we show to be even larger when taking into account also the perception of co-benefits[7].

Neglecting co-benefits would clearly imply an overestimation of the net policy costs, since most studies providing monetary estimates of co-benefits suggest that they are relatively conspicuous compared to mitigation costs, also in the case of Switzerland and other developed countries (cf. e.g. OECD 2014). In fact, co-benefits are in the order of several tens of dollars per ton of CO_2 and may well exceed abatement costs (Baranzini and Carattini 2014). According to Pittel and Rübbelke (2008), co-benefits may be sufficiently large to justify "selfish" cooperation in international negotiations and lead to binding international agreements, of course provided that their existence (and magnitude) is recognized. That is, co-benefits may be a game changer in the political economy of climate change mitigation, if fully internalized in people's beliefs.

Regarding policy drawbacks, all included variables have the expected negative sign, but only loss of purchasing power is significant. Being one of the 67% of the sample affirming that carbon taxes are an issue for purchasing power is linked with about 15% lower probability of accepting the instrument. The concern of losing purchasing power

[7]The coefficient for crowding-out of intrinsic motivation or protest answers does not attain statistical significance. This may suggest that what we face is indeed some motivational crowding-out rather than simply protest, although with no impact on acceptability.

Table 2.1: Testing carbon tax/climate contribution acceptability: marginal effects at median from probit estimation

Acceptability when earmarking is not specified	(1)		(2)		(3)	
Number of cars	-0.0935**	(0.0411)	-0.0540*	(0.0323)	-0.0641*	(0.0340)
Green member	0.267***	(0.0790)	0.212**	(0.0943)	0.196**	(0.0925)
Years of education	0.0286*	(0.0162)	0.0144	(0.0159)	0.0166	(0.0173)
Gender (male)	0.0827	(0.0589)				
Number of adults in the household	0.0284	(0.0283)				
Homeowner	0.0437	(0.0853)				
Age	0.000629	(0.00227)				
Unemployed	-0.0596	(0.189)				
Left	0.134	(0.0836)				
Center	0.0681	(0.0786)				
Right	-0.0533	(0.0902)				
Climate: high concern			0.164***	(0.0616)	0.146**	(0.0673)
Energy consumption: no attention			-0.339***	(0.126)	-0.377***	(0.097)
Energy consumption: very attentive			-0.0483	(0.0785)		
Expected cooperation			0.110*	(0.0624)	0.0675	(0.0665)
Trust in the government			0.200*	(0.112)	0.129	(0.133)
Government intervention: information			0.103	(0.0707)	0.126*	(0.0708)
Government intervention: taxation			0.267***	(0.0635)	0.234***	(0.0693)
Government intervention: subsidies			0.0144	(0.0649)		
Government intervention: none			0.0861	(0.211)		
CT/CC: effect on own behavior					0.186**	(0.0734)
CT/CC: crowding-out or protest answers					-0.0311	(0.128)
CT/CC: environmental effectiveness					0.283***	(0.0672)
CT/CC: co-benefits					0.0387**	(0.0174)
CT/CC: drawbacks (less purchasing power)					-0.165**	(0.0778)
CT/CC: drawbacks (less comfort)					-0.0286	(0.0663)
CT/CC: drawbacks (fear of losing job)					-0.237	(0.172)
CT/CC: drawbacks (distributional effects on the poor)					-0.096	(0.0658)
CT/CC: drawbacks (distributional effects on rural)					-0.0966	(0.0773)
CT/CC: drawbacks (competitiveness effects)					-0.0702	(0.0843)
CT/CC: drawbacks (employment effects)					-0.0352	(0.123)
Labeling (climate contribution)					-0.1253	(0.1799)
Pseudo R^2	0.075		0.175		0.282	
Log pseudolikelihood	-205.772		-185.675		-161.774	
N	321		325		325	

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. In all columns $p > Chi^2 = 0.0001$.

makes sense in particular given that at this stage the use of tax revenues is not specified. However, this concern may vanish over time after carbon taxes are implemented, since the real effect of loss in consumption on well-being may be lower than actually perceived, as income relative to others may be rather unchanged (Gowdy 2008, see also Howarth 2006).

Regressive impacts do not seem to matter in this context. Distributional effects are an issue for an important number of individuals as indicated in the descriptive statistics, but they fail to significantly impact acceptability. This result differ from those of most of the literature but provides quantitative evidence for one of the finding from the focus group of Kallbekken and Aasen (2010), which stress that respondents seem to be concerned by distributional effects, but not enough to pretend environmental taxes not to be regressive.

Competitiveness and employment effects are clearly non-significant. We see four possible explanations for their non-significance. First, individuals may not be concerned about competitiveness issues, consumers having different interests than firms, and about unemployment, since they may have very small empathy for potential jobless and perhaps limited fear of how rising levels of unemployment could affect their own situation. However, this may be in contradiction with the evidence based on voting behavior of Thalmann (2004), in which concern about employment issues contributed to the rejection by the Swiss population of three energy tax proposals in spite of an unemployment rate below 2%. Second, individuals may not expect competitiveness effects to be sufficiently large to become a real problem. This may make sense in the light of the modeling exercise of Sceia et al. (2012), which find very limited terms-of-trade effects for Switzerland when simulating the impact of unilateral moves towards more stringent climate policy. Third, respondents may expect Swiss climate policy to be part of a concerted move undertaken with other countries, e.g. under the umbrella of a renewed Kyoto-like agreement. In such scenario, terms-of-trade effects as modeled by Sceia et al. (2012) become positive. Fourth, the very low concern for employment and competitiveness effects may be also due to the low profile of corporate interest groups at the time of the survey. Indeed, once approaching important votes, the latter tend to employ massive lobbying efforts to have their vested interests internalized by the public, leading the industry flight argument to gain a very important weight in the political discourse (Spash and Lo 2012). This interpretation would call for green lobbying to oppose the industry flight argument and preserve the current outcome (see Dietz et al. 2012).

Altogether, this evidence may question the rationale for the large exemptions and

privileges given to some industries by the carbon schemes of some Scandinavian countries or Australia, which have eventually watered down the environmental impact of the tax itself (see Lin and Li 2011; Baranzini and Carattini 2014). Partially rejecting H1, Table 2.1 suggests that the popularity of carbon taxes may not necessarily imply a trade-off between environmental, distributional and competitiveness effects.

Labeling is not significant at this stage. Regarding the relative performance of the three specifications of Table 2.1, we see that the goodness-of-fit increases as more variables are added, confirming that policy perception does matter for acceptability, beside individual characteristics.

2.3.2 Impact of earmarking on carbon tax acceptability

In this section, we focus on the individuals that do not accept the policy proposal in subsection 2.3.1 and examine whether their choice changes conditional on the implementation of their preferred option of revenue recycling. The variable to be explained takes value 1 for those changing opinion in favor of the CT/CC and 0 otherwise. We then rely again on a probit model, conditional on choosing 0 in the first acceptability question:

$$Prob(Acceptability\ with\ earmarking = 1|x, Acceptability = 0) = F(x, \beta) \tag{2.4}$$

where revenue recycling is introduced as a dummy variable representing respondent's first choice among the three options for recycling presented in the questionnaire. Consistently with the descriptive evidence, we select tax rebates to households and firms as the reference case. The marginal effects are calculated as in (2) and (3).

The estimation reported in Table 2.2 includes variables for revenue recycling and labeling, now significant. The literature gives no priors on the potential impact of socioeconomic characteristics on acceptability conditional on the preferred use of tax revenues. We find that in general none is statistically significant, except for a positive effect again of education (*p-value* of 0.098). Policy variables seem instead confirming our set of hypotheses. Trust in the government is associated with a negative sign and a fairly large coefficient. This makes sense in the light of the positive coefficient of Table 2.1. That is, trust in the government is positively associated with being in favor of the CT/CC regardless of how tax revenues are used, whereas respondents distrusting the government are relatively more likely to reject the first proposal and potentially change opinion in Table 2.2, once revenues are earmarked. Hence, we can confirm hypothesis H3.

Compared to the rest of respondents, those suggesting that the government should

Table 2.2: Carbon tax/climate contribution acceptability with earmarking and revenue recycling: marginal effects at median from probit estimation

Acceptability when earmarking is specified	(1)	
Number of cars	0.0753	(0.0652)
Green member	0.0182	(0.192)
Years of education	0.0392*	(0.0236)
Gender (male)	0.0695	(0.0956)
Number of adults in the household	0.0208	(0.0447)
Homeowner	-0.0912	(0.121)
Age	0.00183	(0.00373)
Unemployed	0.219	(0.275)
Left	0.213	(0.162)
Right	0.119	(0.131)
Expected cooperation	0.0616	(0.0901)
Trust in the government	-0.341**	(0.149)
Government intervention: information	0.157*	(0.0925)
Government intervention: taxation	0.130	(0.115)
CT/CC: environmental effectiveness	0.256**	(0.0996)
CT/CC: co-benefits	0.0461*	(0.0266)
CT/CC: drawbacks (less purchasing power)	0.120	(0.101)
CT/CC: drawbacks (less comfort)	0.0385	(0.0964)
CT/CC: drawbacks (fear of losing job)	-0.437**	(0.192)
CT/CC: drawbacks (distributional effects on the poor)	-0.00170	(0.0966)
CT/CC: drawbacks (distributional effects on rural)	-0.123	(0.102)
CT/CC: drawbacks (competitiveness effects)	-0.126	(0.122)
CT/CC: drawbacks (employment effects)	0.201	(0.155)
Revenue recycling: social cushioning	0.0813	(0.129)
Revenue recycling: environmental projects	0.230*	(0.126)
Labeling (climate contribution)	0.168*	(0.0903)
Pseudo R^2	0.211	
Log pseudolikelihood	-82.128	
N	152	

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In all columns $p > Chi^2 = 0.0057$.

address the issue of energy consumption with taxation do not have a higher probability to change their opinion with earmarking. This is consistent with the result of Table 2.1 and hypothesis H4. In contrast, those asking the government to communicate better the need and possibilities for energy conservation are, everything else equal, more likely to support the tax both unconditionally and conditionally on earmarking. This may point again to the complementarity between taxation and communication.

The effect of perceived effectiveness is in line with our hypothesis. Expecting the tax to work is linked to a positive effect on acceptability, also among those that rejected the first CT/CC proposal. As suggested by the qualitative analysis of Kallbekken and Aasen (2010), being aware of how the incentive effect works does not necessarily imply no demand for earmarking. The marginal effect in Table 2.2 is still pretty large and implies that in this sub-sample the likelihood of voting yes once the use of tax revenues is defined is about 25% larger for those believing the CT/CC to work than for those that do not. On top of that, there is again a positive effect of perceived co-benefits.

We observe that the probability of reconsidering the CT/CC is larger for those selecting recycling for environmental purposes than for those opting for tax rebates (the dummy of reference), everything else equal. The coefficient for recycling through social cushioning (as defined by the respondent) is not statistically significant. Therefore, it seems that earmarking for environmental purposes really matters for acceptability. Since we control for e.g. trust in the government and perceived effectiveness, we relate this demand for environmental recycling with the issue-linkage, i.e. the need for the public to see a straightforward and logical nexus between the tax and the use of revenues (Sælen and Kallbekken 2011). At a given tax rate as in this context, this implies larger abatements, indicating that acceptability tends to go hand in hand with effectiveness (cf. Steg and Vlek 2009).

Finally, we look at labeling. The coefficient for CC (versus CT) is now significant. The fact that the CC treatment affects acceptability only in conjunction with revenue recycling may hint that the term "climate contribution" may not suffice to overcome some general suspicion in the first acceptability question, but it does increase support when earmarking is made explicit. An explanation for this fact may be that in the way we present them, both the CT and the CC look really like taxes. However, once revenues are earmarked for the environment, the CC may become much more appealing as it really looks as a contribution to the climate, whereas the tax still carries the unfortunate "tax" labeling. While hypothesis H4 is here confirmed, chances of wording to matter may decrease in the political arena, with repeated debates and the intervention of political parties, although based on Swiss data Buetler and Maréchal (2007) call for

evidence of framing effect in voting behavior. In this respect, we note with interest that since 2015 the Swiss government publicly refers to a "climate levy" to replace and widen the scope of its current carbon tax.

To sum up, this section sheds new light on the policy perceptions and preferences determining carbon tax acceptability and provides quantitative evidence for the following empirical facts. First, not only the perception of environmental effects but also of potential co-benefits affects acceptability. Second, perceived environmental effectiveness matter much more than competitiveness and distributional effects, which do not seem to clearly impact acceptability. Therefore, there may not be a clear trade-off between environmental, distributional and competitiveness effects. Hence, people may be ready to accept the downsides of a carbon tax if environmental benefits are clearly ensured. Third, the barrier represented by perceived environmental ineffectiveness can at least be partly compensated, as the coefficients show, by earmarking revenues for environmental purposes. Yet, even with earmarking, perceived effectiveness implies higher acceptability. Fourth, trust in the government is positively associated to unconditional acceptability, while negatively with acceptability conditional to earmarking. Fifth, the label "climate contribution", joint with earmarking for environmental purposes, also contributes to higher support for carbon taxes.

2.4 Conclusion

Carbon taxes are an effective instrument for curbing greenhouse gas emissions, yet are seldom implemented (Baranzini and Carattini 2014). This paper applies quantitative analysis to survey data and assesses drivers and barriers to public acceptability of carbon taxes, providing new insights to the question of making carbon taxes popular. Empirical results suggest that a carbon tax could find substantial support in a ballot, but it may not reach the majority without some explicit earmarking. Albeit the political discourse generally focuses on competitiveness and distributional effects (cf. e.g. Spash and Lo 2012), the data analyzed here indicate that individuals are more concerned by the environmental effectiveness of the tax than on such drawbacks. Indeed, we show that perceived environmental effectiveness and expectation of local co-benefits are the main drivers of acceptability. Competitiveness effects are almost completely neglected, whereas distributional issues (in particular regarding poor and older households) seem to represent a real concern for the general public, but with little impact on acceptability.

According to our findings, communicating both primary and ancillary benefits of carbon taxes seems to be essential for improving acceptability. Along with earmarking,

this could be very useful to reduce the opposition related to mistrust in the government and Ramsey-type tax aversion (see Kallbekken et al. 2011). In this respect, we find that in terms of acceptability the best way of recycling the tax revenues is to give the priority to environmental spending. In the same vein, we also provide evidence that using a different label, viz. "climate contribution" rather than "carbon tax", can be beneficial in terms of acceptability.

Therefore, our empirical findings provide evidence that with appropriate design the chances for climate policy tightening could be substantially improved. To the extent that extrapolation from our data is possible, our results would hint that the Swiss population may accept relatively ambitious energy and climate policy of the kind it rejected in 2000, provided that policies are properly conceived and advertised. The evidence that we provide may also guide policymaking in all other contexts wherein the popularity of policies matter for their chances of implementation. The European experience of environmental taxation and in particular of the (planned) environmental tax reform indicates that a considerable level of popularity is a requirement for implementation in virtually all contexts (see the special issue introduced by Dresner et al. 2006). Transposability of survey estimates to political support and actual voting needs however to take into account the room for hypothetical bias and variation in timing, which is linked to media coverage, lobbying and business-cycles effects.

Chapter 3

Is taxing waste a waste of time? Evidence from a quasi-natural experiment in the Canton of Vaud, Switzerland[1]

This paper exploits a ruling decision of the Federal Supreme Court of Switzerland to causally assess the effectiveness of pricing garbage by the bag in the Canton of Vaud. We interview households twice and thus collect a panel of household waste data. We couple survey data with official cantonal data. With both datasets we find that pricing garbage by the bag reduces incinerated garbage per capita by about 40%. The reduction in incinerated garbage comes with an increase in the frequency of recycling. The seldom application of unit-pricing schemes does not seem to rely then on a lack of effectiveness. We address the question of political feasibility and assess an important gap between acceptability *ex-ante* and *ex-post*. The direct experience of pricing garbage by the bag improves the general public's perception in terms of both effectiveness and fairness. Willingness-to-pay per taxed bag more than doubles.

3.1 Introduction

From an economic perspective, waste collection represents a private good since any additional bag or container generates additional costs to the community (rivalry) and

[1]Chapter written with Andrea Baranzini and Rafael Lalive. I thank the seminar audience at the University of Barcelona and the Autonomous University of Barcelona as well as the participants to the 3rd PhD Workshop on Industrial and Public Economics, Reus, and the ZEW Public Finance Conference, Mannheim.

since excludability can be introduced thanks to the use of e.g. special bags (Fullerton and Kinnaman 1996). Pricing garbage by the bag allows to attribute to households the relative waste management costs, according to the polluter pays principle, well-known since Pigou (1920). Pay-per-bag fees and other measures of waste taxation are not very diffused in developed countries, though (Halvorsen 2012). We see two potential reasons for this fact. First, local, subnational or national authorities may not have the interest to put these measures forward since their administrative costs may exceed the benefits from increased recycling and decreased incinerated waste. For instance, negative net benefits are suggested by the cost-benefit analysis of Kinnaman (2006), based on a series of estimates of unit pricing's effectiveness, including from pay-per-bag programs. However, most of these estimates are not driven by causal analysis. We target this issue by tackling the endogeneity and room for confounders inherent to most economic studies available so far. We thus shed new light on the question of effectiveness by providing a causal estimate. Second, unit-pricing schemes may face a lack of popularity hampering their political feasibility, as it is often the case for environmental taxes. Regressivity may be one of the reasons why the general public may dislike this type of measures (Fullerton and Kinnaman 1996, Husaini et al. 2007). Some mistrust surrounding the instrument, the 'real' rationale for its implementation and its effectiveness may also contribute to explain a potential lack of acceptability. We address these issues by evaluating pricing garbage by the bag's acceptability and perception by the public before and after its implementation. In this way, we provide empirical evidence on a question overly neglected by the existing literature.

To do so, we exploit the quasi-natural framework provided by a Federal Supreme Court of Switzerland's decision of July 4$^{\text{th}}$ 2011, which ordered the application of the polluter pays principle in the case of household's waste to all municipalities in the Canton of Vaud. This decision created a large wave of new implementations in the Canton's municipalities, having taken place on January 1$^{\text{st}}$ 2013. We use these municipalities as treatment group, whereas those already possessing such policy constitute the control group. We use interviews, before and after January 1$^{\text{st}}$ 2013, to assess the policy's effectiveness and changes in perception. Therefore we are able to isolate the effect of the policy on the amount of incinerated garbage produced by households, on the level of recycling and on its acceptability. This study is the first of its kind, to the best of our knowledge.

Our results suggest that pricing garbage by the bag allows for a sharp drop in the volume of incinerated waste and spurs recycling of materials such as aluminum and organic waste. We compare estimates from the survey data with official data provided

by the Canton. No matter the data used, on average the tax reduces incinerated garbage by about 10 liters per capita per week, to be compared to a prior level of about 27 liters per capita per week. Estimates are robust to the possible endogeneity of policy choice and simultaneity. We also find a large increase in acceptability following the implementation of the pay-per-bag fee, along with a better perception of the fee's effectiveness and a reduced feeling of injustice vis-à-vis the policy. In terms of stated willingness-to-pay for pricing garbage by the bag, the treatment generates an increase of at least 100% in the willingness-to-pay for a 35-liters bag.

3.2 Economic background

Since the '90s unit pricing has been the focus of many economic studies, which have attempted to assess its effectiveness (for a survey cf. Kinnaman 2006 or Yang and Innes 2007). Since unit pricing may have perverse effects, such as inciting to illegal dumping or to "waste tourism", when assessing its effectiveness it is important to look not only at the change in solid waste produced by households but also at the frequency of sorting, whose increase is the desired effect from taxation. Following Jenkins et al. (2003), the frequency of recycling should be assessed for each materials, facilitating in this way the possible conversion in monetary benefits which associates different prices to different raw materials.

The literature considers many of the different programs that have been implemented so far in different developed countries, namely pricing garbage by the bag (or by tags, stickers), weight pricing and subscription programs. In terms of effectiveness, subscription programs tend to underperform the other two schemes, as the marginal cost of additional garbage may be zero if households remain stuck with a given number of containers for which they subscribed (Kinnaman and Fullerton 2000; Kinnaman 2006). According to the review of Kinnaman (2006), pay-per-bag fees and weight programs perform in a very similar way (in common units, i.e. pounds of garbage reduction per dollar of user fee), but operating weight programs is generally much more costly. That is, it seems that the phenomenon of compressing waste to reduce volume under pay-per-bag fees (the so-called Seattle Stomp) does not represent a real issue for volume pricing. One would expect volume pricing to also incite consumers to look for less voluminous wrapping while shopping (Jenkins et al. 2003).

The estimates for pricing garbage by the bag reviewed in Kinnaman (2006) range from about 1 to 10 kg of avoided incinerated waste per households per week per 1$ fee. Reported price elasticities of demand range approximately from -0.08 to -0.39

(Kinnaman 2006), pointing to incinerated garbage as a relatively but not completely inelastic good and thus supporting the fee's effectiveness. This reconciles unit-pricing schemes with other types of environmental taxes. Yet, we recall that the estimates in the literature may be biased due to endogeneity and confounders.

We should note at this point that recycling may exist also absent any price incentive, as a norm-lead private provision of a public good (cf. Bruvoll et al. 2002; Brekke et al. 2003; Halvorsen 2008; Hage et al. 2009; Viscusi et al. 2011; Halvorsen 2012; Abbott et al. 2013). That is, households may be willing to assume important costs to recycle and thus comply with norms. Bruvoll et al. (2002) estimate at 44 hours per year the time spent by Norwegian households in recycling activities. However, this private provision may not be sufficient to reach the social "optimum", as individuals can hardly participate to the provision of all public goods (Nyborg et al. 2006). Unit pricing thus introduces a monetary reward for the time spent recycling, decreasing its opportunity costs[2]. According to Thøgersen (1994), when unit pricing is implemented this monetary reward becomes the main rationale for recycling. Though, no evidence so far suggests the risk of motivational crowding-out, which may lead to a decrease in recycling as suggested in other fields of environmental taxation (see e.g. Bazin et al. 2004; Goeschl and Perino 2012).

On the question of public acceptability, the literature is much scantier. Distributional issues are evaluated by Kinnaman and Fullerton (2000), which estimate the income elasticity of incinerated garbage between 0.05 and 0.57 (thus making unit pricing regressive), and discussed by Husaini et al. (2007) with respect to the British legislation, which is very sensitive to this issue and as a result opposed so far to unit pricing. Besides their undesirable distributional effects, environmental taxes may be in general perceived as a constraining instrument, for instance as opposed to subsidies (Steg et al. 2006). Consistently, a recent strand of literature on the acceptability of carbon taxes emphasizes how the incentive effect of environmental taxes may be misunderstood by the public and this may make "Pigouvian" taxes be felt as Ramsey taxes unless revenues are earmarked (see e.g. Thalmann 2004; Dresner et al. 2006; Kallbekken and Sælen 2011; Kallbekken et al. 2011 and Chapter 2 of this thesis). Yet, the cross-country comparison of Husaini et al. (2007) suggests that, where implemented, unit pricing enjoys a relative popularity among the general public. This may be a signal that acceptability *ex-ante* and *ex-post* can differ. In this respect, the study of Thøgersen (1994) provides an interesting figure: public support for unit pricing is on average 51% in the Danish

[2]Facilitating recycling e.g. with curbside recycling also decreases its opportunity costs (see again Kinnaman 2006).

municipalities in its study, but increases to 79% when the interviewer emphasizes the net benefit that a standard household may enjoy once tax revenues are redistributed (lump sum) to the population.

In Switzerland unit pricing exists since about two decades, but in a very heterogeneous fashion. This heterogeneity is the result of the principle of subsidiarity, according to which municipalities have the right to decide their own way to deal with waste management unless cantonal or federal laws prescribe otherwise. While unit pricing is much diffused in the Swiss-German area, its application in the Latin parts of the country is limited to the Cantons of Fribourg and Neuchâtel (unit pricing introduced in 2012) and to some municipalities of the Cantons of Jura, Ticino and Vaud. These cantons, along with Geneva, are known to have been historically reticent to such policy. For instance, the population of Jura rejected unit pricing in a public ballot in 1998. A limit to the principle of subsidiarity comes however from a series of 1997's law articles aiming at protecting the environment and imposing a principle of causality in the way waste collection is managed, thus forcing in theory the implementation of unit pricing at the municipal level. In the Canton of Vaud these articles were nevertheless not enforced until a simple citizen of a municipality called Romanel-sur-Lausanne initiated a lawsuit against the local government for not respecting the principle of causality in financing waste collection. The final ruling of the Federal Supreme Court in favor of this citizen started a legislation process at the cantonal level that eventually lead to a large wave of unit pricing's implementations in the Canton's municipalities. Indeed, the Supreme Court required the implementation of unit-pricing schemes financing most of waste collection, while keeping lump-sum taxes as a complementary source of revenue. We exploit this exogenous source of variation as basis for the identification strategy.

3.3 Methodology

3.3.1 Empirical framework

We anticipated a general weakness common to the previous studies, which relies on the policy endogeneity and the possibility for confounders to bias the estimations (cf. Besley and Case 2000). Two sources of endogeneity are acknowledged by Kinnaman and Fullerton (2000). On the one hand, environmental-friendly communities may be relatively more likely than others to introduce a unit-pricing system. Cross-sectional comparisons may thus overestimate the policy's effectiveness, since these communities may generate lower amounts of garbage anyway, i.e. regardless of the policy. On the

other hand, communities with very high levels of garbage per capita may consider to implement such policy to converge towards a "standard" level of garbage production. Cross-sectional comparisons may thus underestimate the policy's effectiveness. Kinnaman and Fullerton (2000) attempt to identify the direction of (and correct for) this self-selection bias by estimating in a first stage the endogenous likelihood of implementing a unit-pricing system (see also Dijkgraaf and Gradus 2004, 2009 for similar attempts). Their finding suggests that the second source of bias may dominate, i.e. simple cross-sectional analysis would underestimate the policy's effectiveness. Time-series analyses for the same community, as in Fullerton and Kinnaman (1996), do not face this issue, but, absent any control group acting as counterfactual, estimates may be biased by confounders (i.e. simultaneity). This bias may be very large if garbage is measured at different moments of the year, as seasonal variation may be considerable (cf. Sterner and Bartelings 1999; Yang and Innes 2007). Other elements, such as citizen's environmental friendliness, may also change over time. Non-tax policies (e.g. awareness-raising campaigns) may also affect the amount of solid garbage produced by households. In Fullerton and Kinnaman (1996) the authors collect data for other communities, regarded as similar, in an attempt to correct their estimates.

Our empirical approach aims at overcoming these issues. We collect data for households both in a treatment and a control group before (in 2012) and after the treatment (in 2013) and apply a difference-in-difference approach. Our treatment and control groups are defined more in detail in the next subsection. To formalize and illustrate our approach (cf. Angrist and Pischke 2009), we apply it to two illustrative municipalities, say Begnins (Be, treatment group) and Agiez (Ag, control group). Household i's garbage production in municipality c at time t is given by Y_{1ict} in presence of treatment and Y_{0ict} otherwise. We assume the level of garbage production absent any treatment to be dependent on time (λ_t) and municipality characteristics (γ_c the municipality-specific fixed effect) such that:

$$E(Y_{0ict}|c,t) = \gamma_c + \lambda_t \tag{3.1}$$

Assuming parallel trends and given generally uniform and linear pricing across municipalities[3], we assume β to measure the effect of treatment with the treatment status being defined by D, i.e. β=E(Y_{1ict}-$\mathrm{Y}_{0ict}|c,t$). Hence:

$$Y_{ict} = \gamma_c + \lambda_t + \beta D_{ct} + \epsilon_{ict} \tag{3.2}$$

[3] 1 Swiss franc (close to parity with the US dollar at the time of writing) for a 17-liters bag and 2 Swiss francs for a 35-liters bag.

where the error term ϵ is such that E($\epsilon_{ict}|c,t$)=0.

Taking the same example as before, the difference-in-difference approach implies estimating (3.2) with Be_c being a dummy variable for the municipality of Begnins and thus taking value 1 for Be and 0 for Ag. γ thus measures the fixed effect specific to Be, compared to Ag. Since we define $Be_c \cdot d_t = D_{c,t}$, with the dummy variable d_t taking value 1 for 2013 and 0 otherwise, β still measures the effect of treatment. Taking Begnins and Agiez as representative of the two groups and recalling that the treatment takes place in 2013, we can assess the counterfactual:

$$E(Y_{0ict}|c{=}Ag,t{=}2013) - E(Y_{0ict}|c{=}Ag,t{=}2012) = \lambda_{2013} - \lambda_{2012} \tag{3.3}$$

The effect of treatment β can thus be isolated from what is observed in the treatment group as in (3.4), taking into account the counterfactual. (3.5) gives the difference in difference:

$$E(Y_{1ict}|c{=}Be,t{=}2013) - E(Y_{0ict}|c{=}Be,t{=}2012) = \lambda_{2013} - \lambda_{2012} + \beta \tag{3.4}$$

$$\begin{aligned} &E(Y_{1ict}|c{=}Be,t{=}2013) - E(Y_{0ict}|c{=}Be,t{=}2012) \\ &-(E(Y_{0ict}|c{=}Ag,t{=}2013) - E(Y_{0ict}|c{=}Ag,t{=}2012)) = \beta \end{aligned} \tag{3.5}$$

If the underlying assumptions are verified, β is unbiased and measures the average causal effect of our treatment. In this framework, both *compliers* and *defiers* may be averaged out when computing the effect of treatment, since the treatment may crowd out the intrinsic motivation for recycling of some households. Municipality-specific fixed effects are evened out in the difference-in-difference approach, as shown by (3.6):

$$\Delta Y_{ict} = \Delta\lambda_t + \beta\Delta D_{ct} + \Delta\epsilon_{ict} \tag{3.6}$$

Since households characteristics may vary between municipalities and groups, we conservatively introduce a vector of control variables such as X'_{ict} for household i in municipality c at time t to test the robustness of (3.2):

$$Y_{ict} = \gamma Be_c + \lambda d_t + \beta(Be_c \cdot d_t) + X'_{ict}\delta + \epsilon_{ict} \tag{3.7}$$

However, some of the outcomes that we observe are binary. Hence, a linear model may provide a poor approximation. We may thus want to compare linear estimates with models that are logically consistent with the binary Y_{ict}. For instance, a variable

capturing whether a household i in municipality c sorts at time t a given material takes either value 1 if the household does or value 0 if it does not. Independent variables, including the treatment, are thus expected to contribute to explain the likelihood of the observed sorting choice. In this case, a Probit model would be more appropriate. We may want to rewrite equation (3.2) as a probability model. The fixed-effect panel data model now writes as:

$$Pr(Y_{ict} = 1) = Pr(Y^*_{ict} > 0) = Pr(\epsilon_{ict} > -\gamma_c - \lambda_t - \beta D_{ct}) = F(\gamma_c + \lambda_t + \beta D_{ct}) \quad (3.8)$$

where F is supposed to follow a normal distribution. Hence, partial effects (PE) are given by
$PE = Pr(Y_{ict} = 1|\bar{x}_{(D_{ct})}, D_{ct} = 1) - Prob(Y_{ict} = 1|\bar{x}_{(D_{ct})}, D_{ct} = 0)$ if the change is discrete also in the independent variable, i.e. the treatment. In this case $\bar{x}_{(D_{ct})}$ stands for the mean of all variables but D_{ct} (cf. Greene 2011). The same would apply to model (3.7). PE for continuous independent variables would be obtained as $PE = \frac{\partial F(.)}{\partial x}$ which is obtained by multiplying β for the normal density so that $f(x'\hat{\beta})\hat{\beta} = \hat{f}\hat{\beta}$.

However, since for a fixed T the number of unknown parameters γ_c increases with N, such specification would face the incidental parameters problem, which implies that the coefficients for the municipality-specific fixed effect are inconsistent. Applying a random-effect model allowing for a Chamberlain/Mundlak correction introducing the mean of time-varying variables in the main specification would help, but this would not be possible absent time-varying independent variables. We can still estimate (3.8) by "brute force" (cf. Greene 2011), knowing that this technique introduces an upward bias of 100% when T=2 as in this context.

3.3.2 Treatment and control groups

Unit pricing in the Canton of Vaud exists since the early '90s. In July 2012, 78 municipalities over 326 had either a pay-per-bag fee, a weight-pricing system or an alternative scheme which consists in paying a fee anytime an individual opens one of the municipal containers at a drop-off center. We do not include in the control group municipalities introducing lump-sum taxes during the treatment period, municipalities changing their status due to merging processes as well as municipalities having opted for a pricing scheme which is not pricing garbage by the bag. Eventually, we keep 50 municipalities. The treatment group is composed of all municipalities introducing a pay-per-bag fee on January 1st 2013 and whose decision was formalized at the time of starting the inter-

views[4]. We exclude municipalities implementing other pricing schemes or introducing lump-sum taxes in the same time as unit pricing, for sake of consistency with the control group. New lump-sum taxes are avoided not to bias the analysis of acceptability. Again, merging municipalities are dropped. For the treatment group we consider 20 municipalities.

Since households are the decision unit for garbage and recycling, Jenkins et al. (2003) advise to use household data to evaluate unit pricing's effectiveness. We thus asked a marketing firm to deliver 30 randomly-selected addresses for each of these 70 municipalities. For some municipalities less than 30 (but always more than 12) addresses were available. Overall we received 1380 and 599 addresses for the control and treatment groups, respectively. We administered the first round of interviews in November and December 2012 and the second round between April and June 2013. At the first round we collected data from 228 and 124 households for the control and treatment groups, respectively. In theory, this would imply a response rate around 20%. However, we note that due to time and budget constraints we could not contact all households whose addresses were available. Among these 352 households, 193 participated also to the second round. 193 is thus the size of our panel. The response rate at the second round is close to 55%. The sample is composed of 107 (86) households in the control (treatment) group. This panel is the main source of data for our estimations. Yet, in what follows we also compare household panel data with official data from municipalities. When official data is available, it is for all municipalities in the Canton. Control and treatment groups can thus be defined over the whole Canton (see subsection 3.4.3).

3.3.3 External validity

Use of survey data implies that we may face a selection bias. The question of external validity is particularly important when assessing pay-per-bag's effectiveness, whose estimate should be representative of the general treatment effect. However, since we select a series of municipalities in both groups and the number of addresses received is bounded at 30 disregarding the municipality's size, our sample is not conceived to be representative of the cantonal population[5].

[4]Despite the large uncertainty surrounding the legislative process at the municipal level in the autumn of 2012, most municipalities introduced the unit-pricing scheme on January 1st 2013. However, some municipalities postponed its implementation to later periods in the year or to 2014.

[5]For illustrative purposes, comparison of the sample with the cantonal population can be done on the basis of Tables C.1 and C.2, which show for a series of socioeconomic variables the average values for our sample and for the cantonal population.

We tackle the issue of external validity as follows. First, we use socioeconomic controls to compare for each group the characteristics of the households participating only to the first round of interviews with the sample interviewed twice, i.e. our panel. In Table C.1 we highlight all variables for which the statistical test suggests that the averages are different between the samples. A few variables are concerned, e.g. education, income, distance from collection centers. Data in Table C.1 allows also to compare the characteristics of the treatment and control groups. Indeed, since we approximate from the control group the unobserved counterfactual, we need the two groups to be as similar as possible (*ex-ante*). We exclude from this comparison data on solid waste and recycling, since in this specific context the control group has already been treated. We verify in a later stage that the choice of an already-treated control group has no implications for this study (see section 3.4). The comparison of panel data between the treatment and the control groups suggests that they are fairly homogeneous. However, given also the risk of sample selection, we present in the next section estimates from both models (3.2) and (3.7).

Second, we provide a series of robustness tests comparing estimates from our survey data with official data measured by municipalities. Municipalities provide yearly figures in kilos for aggregate solid garbage per capita[6]. We obtained data since 2008. This data allows us to perform the following tests. First, we can compare the evolution of solid garbage per capita and assess whether treatment and control groups follow parallel trends from 2008 to 2012 (cf. Angrist and Pischke 2009). Second, we can run estimations of model (3.2) with the official data for the subset of municipalities composing the survey sample and compare with the survey estimates. Densities are available to convert from weight (kilos) to volume (liters). In this way we can check whether the households answering to our questionnaire are different from the underlying population of the municipalities concerned. Third, we can exploit the full scope of the official data and run estimations of model (3.2) with all municipalities already pricing garbage by the bag by the end of 2012 as (extended) control group and all those starting to price garbage by the bag on January 1st 2013 as (extended) treatment group. This procedure is important to determine whether our selection of municipalities has any influence on the outcomes studied here. Fourth, comparison with other types of policy, such as based on weight, is also undertaken. Fifth, we exploit the municipalities postponing the implementation of unit pricing to 2014 and allow them to form a secondary control group. Model (3.2) is thus estimated with the usual treatment group and this secondary

[6]Straightforwardly, we do not have official data on acceptability. In this case inference relies completely on survey data.

control group.

3.3.4 Data and descriptive statistics

This section presents the survey data used for the main estimations. The survey is structured in three parts. In the first part, we ask households about their behavior regarding solid waste and recycling of the following 9 materials: PET, carton, paper, clothes, glass, cans, organic waste, batteries, and aluminum. The second part of the questionnaire concerns unit pricing's perception and acceptability. The final questions provide us with the standard socioeconomic variables (cf. Table C.1).

Table C.3 presents the descriptive statistics for the outcome variables concerning unit pricing's effectiveness: solid garbage per household and per capita, recycling of the 9 materials and attention to voluminous wrapping. Solid waste is measured in liters per week. This value is obtained by multiplying the number of bags used per week with their volume (17 and 35 liters are the most common sizes in Switzerland). 15 households do not report their solid waste production in either 2012 or 2013 (or both). Taking into account these missing values, total observations for solid waste are 371. Recycling variables take value 1 if the household sort a given material and 0 otherwise. Hence, we do not measure the intensity of recycling but rather the probability of doing it. Arguably we can assume that households stating that they recycle a given material do it in most cases, even though probably not in all. Viscusi et al. (2011) describe recycling as a dichotomous choice with corner solutions, i.e. people recycle or do not recycle at all. This is the result of the following proposition: if for a given household is desirable to recycle n units of material, then it is likely to be desirable to recycle $n+1$ units (Viscusi et al. 2011). The choice of frequency over intensity of recycling clearly simplifies the task to interviewees, which are not asked to estimate the share of a given material that is recycled. This estimation may indeed be cognitively demanding and possibly lead to a substantial difference between stated and reported behavior (Sterner and Bartelings 1999). We apply a binary simplification also to voluminous wrapping: we ask to households whether they pay attention to wrapping or not.

Descriptive statistics are given for the treatment and control groups for 2012 and 2013. According to Table C.3, the percentage of households recycling e.g. carton in the treatment group rises from about 84.9% to 96.5%, the difference being statistical significant at 1%. However, this should not be interpreted as the treatment effect. To assess the treatment effect one has to take into account also the change in recycling that may take place in the control group.

3.4 Empirical results: effectiveness

3.4.1 Survey results

We start this section by assessing the treatment effect on the amount of solid waste produced by households. Provided that there is an effect on solid waste, we then need to verify that this is accompanied by an increase in recycling and in the concern for wrapping materials, to ensure that households respond to the fee in a desirable way, i.e. not by simply compressing their waste, throwing it in public bins, in the containers of municipalities without the fee or in the nature. The top panel of Figure C.1 shows the variation over time in the volume of solid waste per capita per week in the treatment and control groups. The bottom panel zooms on the difference and provides a first approximation of the difference in difference, i.e. the treatment effect, which is of about -10 liters and statistically significant, as indicated by the confidence intervals.

Column (1) in Table C.4 translates this effect into numbers, by estimating model (3.2) with ordinary least squares (OLS)[7]. We introduce control variables in column (2) and thus estimate model (3.7). Since some missing values affect control variables, in column (2) the number of observations is slightly reduced, from 371 to 359. In all columns the dummy associated with the year 2013 is statistically significant. This confirms the need for a counterfactual. In this specific case, the counterfactual implies a decline of about 3 liters per capita per week, regardless of unit pricing. The treatment effect amounts to about -10.5 liters per capita per week. By introducing control variables in column (2), we test whether this effect is robust to possible differences in the groups' socioeconomic characteristics. Column (2) shows that it is. The coefficient for the treatment is indeed statistically unchanged. However, several control variables are statistically significant and the goodness-of-fit as measured by the within-R^2 also substantially improves. We thus point to model (3.7) as the appropriate specification and discuss the estimates accordingly.

In 2012, the average solid waste volume per capita per week in the treatment group was slightly above 27 liters. This implies that the treatment generates a decline in solid waste of about 40%. Comparison with other studies is still relevant, in spite of the possible endogeneity and simultaneity. In this respect we remark that the effect of Table C.4 is in the range of what found by e.g. Fullerton and Kinnaman (1996), a decrease in volume of about 37%, and Yang and Innes (2007), a decrease in volume of

[7]OLS is used in all specifications unless otherwise specified. Fixed effects are justified by a $\chi^2(2)$ of 32.08 ($p > \chi^2(2) = 0.0000$) in the Hausman test for model (3.2) and a $\chi^2(20)$ of 43.35 ($p > \chi^2(20) = 0.0018$) for model (3.7). We use clustered standard errors (clusters per municipality) in all specifications where it is justified by the standard heteroscedasticity tests such as modified Wald and Breusch-Pagan/Cook-Weisberg tests.

about 27%.

The negative coefficient is however obtained by averaging out the response of each household, everything else equal. Hence, it is not sufficient to rule out the possibility of some motivational crowding-out. However, a careful examination of the data indicate that although there are a few households increasing their solid waste production, their number or the magnitude of the increase does not appear to be more important in the treatment than in the control group. Based on this evidence, we refrain from further analyses on the unlikely presence of motivational crowding-out.

From Table C.4 we see that EU nationals tend to produce per week about 4 liters more of solid waste than their Swiss homologues (the reference case), whereas no effect is found for citizens of countries other than the EU and Switzerland. A possible explanation for the coefficient for the EU may rely on cultural differences. Data inspection suggests however that such differences exist also within the country. Swiss nationals native from cantons such as Appenzell Inner Rhodes, Fribourg or Valais produce on average lower levels of garbage. Although important cultural differences exist also between cantons (cf. e.g. Basten and Betz 2013), a compelling explanation may be that people from other Cantons (countries) may have more (less) experience with recycling. Given the limited amount of observations we do not push this discussion too far and leave it for further research.

Not surprisingly, a high level of education as measured by possessing an university degree is related to less solid waste per week per capita (about 8 liters) compared to having completed only the compulsory education (the reference case). It is indeed common in the literature to have pro-environmental behavior positively associated with education (cf. e.g. Jenkins et al. 2003 for the case of garbage). Professional categories have instead no effect (with respect to students). We control for income using the six categories of the questionnaire and thus mirroring the classification in the official statistics. The sixth and highest category is the dummy of reference. To deal with the many missing values, we include another dummy variable taking value 1 if income is not reported. The coefficient for this variable is negative and statistically significant as are those for other low-income categories (income 1 and 3), suggesting some self-selection in the income question related with lower incomes. The negative effect for low-income households is in line with the economic prediction, since high-income households have larger levels of consumption and higher opportunity costs of recycling (cf. e.g. Hong 1999). Gender, age and green membership have no significant effect on the amount of solid waste produced by the household. We emphasize the following qualification: socioeconomic variables are given for the household's representative

answering the questionnaire, whereas waste management is rather a household decision.

We find a negative effect for the number of adults in the household. The literature points to economies of scale (cf. e.g. Sterner and Bartelings 1999; Halvorsen 2008, 2012) and especially to a better allocation of recycling tasks within large households, taking into account the differences in opportunity costs (cf. Sterner and Bartelings 1999). Unfortunately we cannot control for the living area (cf. Sterner and Bartelings 1999), which could also be contributing to this effect. We know however whether the household owns or rents its housing, and in the Swiss context ownership is usually associated to single houses rather than apartments (cf. also Halvorsen 2012; Abbott et al. 2013). Table C.4 shows that the coefficient for renting (with respect to owning) is not statistically significant.

The statistically significant coefficient for distance from a collecting center shows the importance of installing collection centers close to the final users reducing the households' cost of recycling. We relate this finding to the vast literature on the effectiveness of drop-off centers and curbside recycling programs (cf. e.g. Jenkins et al. 2003; Halvorsen 2008; Hage et al. 2009).

A graphical analysis similar to the one presented in Figure C.1 can be done for all 9 recycling materials plus wrapping. For sake of space we summarize the relative finding in Table C.5. Table C.5 describes the changes in the frequency of recycling for the 9 materials for both groups and derives the implications for the treatment effect. For instance, in the case of PET there is no observed statistical change in the treatment group. However, there is a decline in the frequency of sorting in the control group. Therefore, taking the control group as counterfactual implies that absent the treatment the frequency of recycling would have declined also in the treatment group. The treatment effect is thus positive. This is the case of all materials but clothes, based on Table C.5. The case of clothes may be peculiar, since this type of material tends to be recycled with a lower frequency. This may imply that households in our sample have not faced the issue of whether to sort or not clothes during the period between the two interviews. Following Table C.5, it seems that there is no change in behavior related to the attention to voluminous wrapping. This is for the graphical analysis.

Table C.6 reproduces the same approach of Table C.4 for all recycling materials plus wrapping and thus provides robust evidence on the treatment's recycling-side. These estimates are more conservative than those given by the graphical analysis summarized in Table C.5, since relying on clustered standard errors and controlling for the relevant socioeconomic characteristics and municipality-specific fixed effects. Since dependent variables measure a discrete change, we also run a Probit model, as detailed with respect

to equation (3.8). Estimates from Probit are reported in Table C.7. Since estimates from Table C.7 are very similar to those obtained with OLS, taking into account the brute-force bias (cf. Greene 2011), and given the lost observations when success or failure are perfectly predicted, we comment the empirical results based on estimates from Table C.6. Probit models do not substantially improve the estimations controlling for socioeconomic variables, either[8].

Odd columns apply model (3.2) to the frequency of recycling. Even with clustered standard errors, the treatment effect keeps sign and significance as in Table C.5 for all materials but PET and batteries. The year dummy is never significant, which introduces a difference compared to Table C.4. Hence, no significant "exogenous" change in the recycling behavior takes place between 2012 and 2013. Treatment effects are the largest in the case of aluminum and organic waste. The estimate for aluminum suggests that pricing garbage by the bag leads almost a quarter of the sample to start sorting this material. It does not surprise that these two materials enjoy the larger increase in the frequency of recycling. Organic waste is mainly associated with bad smell and other practical issues, whereas aluminum often comes in tiny quantities which, taken alone, may not induce people to start sorting without monetary incentives. Conversations with local practitioners indicate that the increase in the number of households involved in sorting organic waste is associated with a decrease in the quality of the latter, with a higher presence of "foreign bodies". It is however suggested that this practices are related with a lack of experience rather than an attempt of cheating. A telling example is the use of non-organic bags for organic waste. There is also little evidence of diffused illegal or undesired practices in the context under observation, which reconciles with the Swedish context of Sterner and Bartelings (1999).

Even columns introduce controls as in model (3.7). Again, the use of control variables implies a slight reduction in the sample size, e.g. from 386 to 368 for recycling materials. Only the treatment effects for aluminum and organic waste are robust to the inclusion of control variables. That is, the most conservative estimates from columns (2) and (12) confirm that there is an increase in the frequency of recycling of organic waste (of about 14%) and of aluminum (of about 20%). These effects are not only statistically significant but also considerably large from an economic perspective. They imply that at least 20% of households in the sample adapt their behavior to unit pricing and start sorting at least one additional material. Regarding batteries, carton, glass and paper the coefficients remain positive but are no longer large enough to reach significance.

Statistically significant control variables include (depending on the specification):

[8] All additional tables are available by the authors upon request.

age, EU and rest-of-the-world citizenship, some socio-professional categories such as jobless, self-employed workers or managers (compared to students), distance and a few income categories (mainly low-income). We discuss the possible rationales for some of these effects. Age is positively associated with the frequency of organic waste, paper and PET recycling. Age itself may determine the likelihood of sorting these materials (cf. e.g. Jenkins et al. 2003; Hage et al. 2009), but it is also common that elderly enjoy large apartments whose rents are not adjusted to the current market prices. Again, we are not in position to control for the size of living area. Cultural differences linked with the nationality seem supportive of the evidence provided in Table C.4, with Swiss nationals being probably better trained to recycling (cf. Halvorsen 2012 for cross-country comparisons of recycling habits). The number of children in the household seems to increase the frequency of recycling of PET, perhaps because children are made particularly aware of it at school. When significant, the effect of income is in most cases as expected: low-income households have a lower opportunity cost and are thus supposed to be more inclined to sort waste. Differences in opportunity costs may also be related to the socio-professional categories, even though we control for income (but with many missing variables). Indeed, leisure time may be differently allocated to managers compared to students or homemakers, everything else equal.

Finally, the effect of distance from the collection center is negative and statistically significant for all materials except for aluminum and batteries, which may be less difficult to transport than other materials. From Table C.6 we can infer that a decrease in distance of about 10 minutes would lead to an increase in the frequency of recycling of about 6%.

3.4.2 Testing for confounders

The results presented so far seem confirming the relevance of the difference-in-difference approach, especially in the case of solid waste wherein we find a significant and non-negligible effect associated with the year dummy. However, we note that despite the presence of a control group we cannot completely rule out the risk of simultaneity, if there are novelties that concern only the treatment group. This may be the case of policies developed at the same time of the fee and aimed at matching the expected increase in recycling (e.g. new or more developed collection centers, programs of curb-side recycling) or at raising awareness and facilitating the transition to a higher level of recycling (e.g. raising-awareness campaigns). Neglecting these policies, we would tend to overstate the effectiveness of unit pricing.

Hence, we contacted the member of the municipality's council in charge of waste management for all municipalities in the sample and administered a supplementary questionnaire trying to capture the variation in the number of curbside programs, of collection centers, of skips, in the opening hours of existing collection centers and in the frequency of raising-awareness initiatives taking place between the two interviews. Of the 82 municipalities for which we observe at least one household, we obtained answers for 44. All non-tax variables are dummy and coded such that any change that is expected to rise the frequency of recycling and decrease the amount of solid waste (e.g. increasing opening hours, launching a raising-awareness initiative) takes value 1, whereas no change takes value 0. We inspect the data and exclude from the analysis all variables for which a positive value concerns less than 5 households, i.e. awareness-raising tools such as street stands and specific online websites. Own estimations indicate that these variables do not significantly affect the amount of garbage produced and dropping them has generally no effect on the main results. We also face a problem of multicollinearity, since many variables display pairwise correlations between 0.6 and 0.9. This is particularly true among new skips, but also between new skips and better opening hours and of course between having a new collection center and having more skips available. Hence, we generate a continuous variable counting the number of materials covered by new skips, which allows to avoid plugging in correlated skip dummies for each material. Table C.8 gives descriptive statistics for the variables considered in this analysis for both the control and the treatment groups. We observe in Table C.8 that these non-tax measures are not a prerogative of the municipalities in the treatment group, even though they take place in a much lesser extent in the control group. This may allow us to explain the "exogenous" effect related to the year dummy in Table C.4. Therefore, we perform the same analyses as in the previous section to the restricted sample of households living in municipalities for which we have non-tax policy data, to test for the role of possible confounders.

Estimates from the relevant regressions are presented in Table C.9. Since non-tax variables are not available for the whole sample, column (1) recalculates the treatment effect as in the respective column of Table C.4 for the subset of households living in municipalities for which we possess data on non-tax measures of waste management. The treatment effect is statistically unchanged with respect to Table C.4. The time dummy is instead now statistically non-significant. Column (2) adds non-tax variables. The coefficient for the treatment effect is slightly reduced but remains statistically unchanged with respect to column (1). Most non-tax variables are statistically non-significant and the goodness-of-fit is only slightly affected. As one expects, the coefficient for the

number of materials covered by new skips is negative, and statistically significant. The coefficient for the curbside program is also negative, but does not reach significance. At odds with economic intuition, we find a positive estimate for better opening hours, new collection centers (statistically significant) and unaddressed mailshots (very small). We do not have a straight interpretation to these coefficients, which, to the contrary of the treatment effect, should be considered as correlations and not causal effects. What is crucial for us is the impact that possible confounders may have on the treatment effect. We find no impact: estimates from column (2) and (3), with the latter including socioeconomic variables, suggest that simultaneity is not an issue in this framework, based on the variables at our disposal. That is, the coefficient estimated in Table C.4 is robust to the addition of non-tax measures which may take place at the same time that the unit pricing scheme itself. Own estimations indicate that introducing non-tax variables to the regressions of Table C.6 on the frequency of recycling does not change their spirit, even though with non-tax and socio-economic variables we get closer to the constraint represented by limited degrees of freedom. The coefficient for organic waste, for instance, becomes 0.130, statistically undistinguishable from the 0.144 of Table C.4 and remains statistically significant.

3.4.3 Official data

Parallel trends

We exploit the official data reported by all municipalities in the Canton and follow the outline presented in section 3.3. We look at the parallel trends by comparing the average weight of incinerated waste produced by municipalities in the treatment and in the control group. Yearly data are available since 2008, normalized by the number of inhabitants (i.e. kilos per capita). To start we stick to the treatment and control groups as defined in the previous sections, i.e. the subsample of municipalities where we administered the interviews. We exclude from the control group those municipalities having introduced a unit-pricing program between 2008 and 2012, as they deviate from a proper counterfactual. 25 municipalities over 39 experience a policy change during the period. Hence, we compare the treatment group with a subsample of forerunner municipalities from the control group. We compare 14 with 19 municipalities. Figure C.2 shows the parallel trends. Both groups follow a horizontal path with only a limited amount of variation around the steady line given by their level of incinerated waste in 2008. This variation is marginal compared with the large difference in solid waste production between the two groups, which is narrowed only in 2013 when the treatment

group is subject to treatment. Data inspection confirms with placebo tests that the trends are statistically parallel.

Figure C.2 supports the use of an already-treated control group, which could have represented a caveat since in theory the evolution over time may be different for households that are submitted to a tax compared to those that are not. In this respect, official data allows us to perform additional tests, since, despite the imperative given by the Supreme Court's ruling, the implementation of an unit-pricing scheme in a group of municipality is postponed to January 2014 or a later period in 2013 (see below). This group of possible recalcitrants is composed of 121 municipalities and thus accounts for about one third of the total in the Canton.

Figure C.3 shows the trends for the extended treatment and control groups, i.e. taking into account all municipalities in the Canton and not only those considered by the survey data, including the possible recalcitrants. Consistently with the survey approach merging municipalities are omitted from the analysis as well as three municipalities introducing a unit-pricing program during the summer of 2013 (Renens, Epalinges and Belmont-sur-Lausanne). Given the use of yearly data, these three municipality would bias the outcome downward if they would be considered as part of the treatment group. We first stick to pricing garbage by the bag as treatment and then expand to unit pricing in general, i.e. including the few weight programs implemented in the Canton. In 2008 only 7 municipalities have a weight program, compared to 27 with pay-per-bag fees. In 2012 (2013), 14 (18) municipalities have a weight program, compared to 58 (217) with pay-per-bag fees.

Figure C.3 presents the same pattern as Figure C.2 for the extended volume treatment (left diagram). Interestingly, the secondary control group almost perfectly matches the treatment group. A slight divergence appears after 2011 but in statistical terms we can still say that the three groups follow a parallel trend. The same observations apply to the whole sample of municipalities (including weight pricing, right diagram). There is thus no signal of selection into treatment. Thereafter, we consider the former possible recalcitrant municipalities as simple "postponers".

Finally, based on Figures C.2 and C.3, we also stress the persistence of unit pricing's effect on solid garbage per capita.

Survey, pay-per-bag and unit pricing samples

To estimate the treatment effect we focus first on the amount of solid waste sent to incineration in 2012 and 2013 by the subset of municipalities included in the survey

data. Estimates are provided by Table C.10. The first column shows that the implementation of pricing garbage by the bag causes a reduction in the amount of per capita solid waste of about 86 kilos per year. An "exogenous" reduction associated with the time dummy is again present, confirming the relevance of the difference-in-difference approach. The goodness-of-fit is much higher than in the survey estimations, probably due to a lower variability in the (average) per capita waste production between municipalities than between households. Albeit the treatment effect is now given in kilos, it may be converted in liters for the purpose of comparison using the solid waste density provided for Switzerland by BAFU (2014). On average the weight of one liter of solid waste is in the range of 0.125-0.146 kilos. Given a weekly reduction of about 1.65 kilos, in liters we obtain a treatment effect ranging from 11.3 to 13.2 liters per capita per week. This figure is only slightly above what assessed with the household data, over a shorter period. In percentage, with respect to a previous level without treatment of 244 kilos (some 30 liters), we find a reduction slightly above 35%. In theory, household and municipal data may differ since municipal data include waste production from firms, which may behave differently than households, in particular if the tax implementation may lead them to bring their waste directly to incineration. Nonetheless, the comparison of estimates from Tables C.4 and C.10 indicates that the two methods provide comparable and very close estimates for the effectiveness of pricing garbage by the bag. In this respect, we do not find such a difference between volume and weight measures as found in Fullerton and Kinnaman (1996). As noted by Bel and Gradus (2014), a difference is likely to exist mainly when volume pricing is represented by containers instead of smaller units such as bags. This consistency seems also very reassuring in view of the external validity of our survey results. Yet, further tests are provided in what follows.

Dealing with possible confounders, we extend once again the specification of column (1) to control for the other policies that municipalities may have implemented over the period of observation. We do this in column (3). Since we possess data on non-tax policies only for some of the municipalities concerned by the household survey, we shall compare the treatment effect with or without these controls based on the same sample. Hence, column (2) estimates the same specification as in column (1) on the restricted sample of municipalities whose non-tax policy change is known. Even though the reduction in the observations is non-negligible, the coefficients of interests are statistically unchanged between columns (1) and (2). As expected, introducing non-tax policies leads the coefficient for "exogenous" changes related with the time dummy to become statistically non-significant. Hence, it seems that we are able to capture the bulk of

factors other than pricing garbage by the bag acting upon the amount of solid waste incinerated. Again, non-tax policies reduce the treatment effect but not in a statistically significant way. Most non-tax control variables are statistically non-significant and the goodness-of-fit improves only marginally. The coefficients for the number of materials covered by new skips and the better opening hours are negative as the economic intuition would suggest, but do not reach statistical significance. Statistically significant is instead the coefficient for a new collection center: controlling among others for the new skips for recycled materials, a new collection center is related to about a dozen additional kilos of yearly solid waste per capita. We recall that an additional collection center does not represent an exogenous treatment.

Official data also allow us to test whether the treatment effect found so far applies only to the subset of municipalities chosen in the survey data or whether these are representative of the Canton as a whole. As a result, we reproduce in Table C.11 the same approach of Table C.10 using all municipalities in the Canton. Municipalities considered as "postponers" are excluded from columns (1) and (2) and used as secondary control group in column (3). The treatment in column (1) is still pricing garbage by the bag whereas in (2) all unit pricing schemes are taken as treatment. We recall that data on non-tax policies are not available for the full set of municipalities and thus not used here. Estimates from Table C.11 provide further evidence on the external validity of the previous results. Based on 438 observations, the treatment effect is estimated in column (1) at about 80 kilos per capita per year of reduced solid waste. This figure is quantitatively undistinguishable from the previous estimates. Converted in liters per week, it implies a volume reduction going from 10.5 to 12.3. Introducing data also on weight programs does not affect the treatment effect in any statistically perceptible way, cf. column (2). However, since only 4 municipalities opt for a weight-based treatment it is difficult to infer from this outcome that effectiveness does not differ across specific pricing schemes.

Column (3) is estimated using the pricing garbage by the bag extended sample as in column (1) but with the secondary control group in place of the "standard" control group used so far. The magnitude of the treatment remains constant. This corroborates the graphical evidence provided by Figure C.3: in this framework, using an already-treated control group rather than a not-yet-treated control group has no effect on the evaluation of the treatment. We do not find any significant difference also on the time dummy, even though in column (3) the relative coefficient does not reach statistical significance.

In sum, this section provides evidence of the following 8 empirical facts. First,

pay-per-bag fees allow for a sharp reduction in the amount of solid waste produced by households, which is estimated at about 10 liters per capita per week no matter the type of data used (survey or official data). Second, this sharp reduction is accompanied by an increase in the frequency of recycling of e.g. organic waste and aluminum (amongst others, depending on the specification). Third, the difference-in-difference approach is completely justified in view of the presence of factors others than unit pricing affecting solid waste production. Fourth, this section shows that these factors can be associated with a series of non-tax policies put in place by municipalities in both the treatment and the control group. Fifth, this section addresses this source of simultaneity and shows that the estimation of the treatment effect on solid waste production is robust to possible confounders such as non-tax policies. Sixth, this section tests whether the choice of an already-treated control group has implications on the estimation of the treatment effect and provides clear evidence that it does not. Seventh, this section provides graphical and regression-based evidence displaying the mechanics of pay-per-bag fees: treatment and control groups follow parallel trends with a constant gap in the amount of solid waste produced between the two groups as long as the treatment group is not subject to treatment. When it is, it converges "immediately" (i.e. within one year) to the treated "equilibrium". The secondary control group behaves as the treatment group until the latter is treated. Afterward, all groups follow the trend with a gap now between the treatment and the secondary control group. No signs are given of a vanishing effect of the treatment. Eighth, given that all conditions for the identification strategy are fulfilled (absence of endogeneity and simultaneity, parallel trends), causal interpretation of estimates is allowed.

3.5 Empirical results: acceptability

3.5.1 Regressivity

Regressive pay-per-bag fees as discussed in section 2 imply that as household income gets higher, the share of income spent in special garbage bags gets smaller. That is, incinerated garbage is a positive function of income, but the former reacts less than proportionally to a change in the latter. To estimate whether this is the case also in our data, we need to couple data on income with data on solid waste and estimate an income elasticity. Our data allow us to do it, since we possess both variables and a set of controls, but a few simplifications are required by the way income is coded. Since we possess only categorical and not continuous observations for income, we need to take a

point in the income range such as the midpoint to build a continuous variable. Income is also censored at its highest value and so we take the bottom end of the interval as value for the category of income 6. We then take the log of this newly-built variable, as well as of others continuous variables such as solid waste per capita, age, distance and the number of individuals in the households (summing the number of children, which may be zero, and adults). 205 observations are available when regressing solid waste per capita on income (and controls). The estimate for income elasticity is displayed by Table C.12. A value of 0.4 implies that, everything else equal, pricing garbage by the bag has indeed a regressive effect.

However, from an equity perspective a *ceteris paribus* analysis may not be necessarily justified in this framework, since in many municipalities the implementation of unit pricing comes with a reduction in the lump-sum taxes that households have to pay to finance waste management. Since lump-sum transfers are recurrent instruments to decrease the regressivity of environmental taxes (cf. e.g. Baranzini et al. 2000), the net distributional effects are thus ambiguous. We are also aware of other forms of social cushioning taking place in a minority of municipalities, such as the free distribution of a given amount of bags to families with infants. Determining which distributional effect dominates in the municipalities experiencing a reduction in the lump-sum taxes is beyond the scope of this paper, but we believe that there is room for a better assessment of the regressive impacts of unit pricing, which should go beyond the simple computation of income elasticity so common to the literature.

3.5.2 Perceptions

We address the questions of acceptability and policy perceptions by applying to the relative questions in the survey data the same difference-in-difference approach used with respect to the question of effectiveness. Though, we acknowledge that in this case a conservative stance would imply refraining from claiming causality, since a large policy change as the one under scrutiny may change perceptions also in the control group. A second difference with the previous section is that we do not attribute answers to the questions of acceptability and policy perception to the household but rather to the individual that is interviewed. Nevertheless, given our framework, we consider systematic bias in this respect unlikely.

Keeping this in mind, we proceed with the analysis of the main indicators linked with acceptability. Several variables are at our disposal. Summary statistics are reported in Table C.13. Following the literature review of section 3.2, we select the outcomes of

interest based on three axis: perceived effectiveness, fairness and acceptability. Based on the previous discussion, we may expect perceived effectiveness to increase in the treatment group once the fee is seen at work. This may help to reduce some hostility with respect to the fee and perhaps improves also the perception of fairness. Perceived effectiveness and fairness are plausible determinants of acceptability.

We have at our disposal three measures concerning perceived effectiveness. These are *perceived effect on own behavior*, *perceived effectiveness* and *perceived effect on the environment*. The latter is expected to capture the expectation that individuals have of the behavioral change driven by pricing garbage by the bag in terms of solid waste produced by households (i.e. *perceived effectiveness*) and how this behavioral change would in turn affect the environment. *Perceived effectiveness* and *perceived effect on the environment* are thus expected to yield a very similar outcome, unless people would consider the environmental effect of reduced incinerated waste as negligible or would not expect proper management of recycled materials. As indicated by Table C.13, answers to all the three questions present a very similar pattern. Hence, given a larger scope and a relative low number of missing values, we select *perceived effect on the environment* as dependent variable in the regressions (cf. columns (1) and (2) of Table C.14). Socio-economic controls are included in even columns. Since all variables in this subsection are binary, we compare again estimates from OLS regressions with a fixed-effect Probit model estimated with Greene's (2011) brute force method (cf. Table C.15). Taking into account the bias implied by the incidental parameters problem, we observe that both OLS and the uncorrected Probit estimates tend to overestimate the coefficient for the treatment effect. Though, the latter is clearly statistically significant, even when applying the correction suggested by Greene (2011). That is, the treatment is associated with at least one household over ten changing its opinion in favor of the fee's effectiveness. Causal interpretation may be allowed, given that no change affects the control group[9].

Another variable allows us to double check whether the experience of unit pricing improves the understanding of environmental taxes' incentive effect. This variable measures the support for the use of revenues in a different realm than waste management. Economic theory suggests indeed to design environmental taxes so that the tax rate is "optimal" (assuming that marginal benefits and costs are known) and leave the revenues free to fund the projects with the highest social return (which may include reducing

[9]We acknowledge that there could be no effect in the control group because of the treatment in the treatment group, i.e. a correct estimation of the counterfactual might have yielded a non-zero coefficient. Though, it is arguably more plausible that the statistically non-significant effect for the time dummy suggests that the control group was not affected neither by the treatment nor by other factors taking place in 2013.

existing distortionary taxes). However, most members of the general public ask instead to earmark environmental tax revenues for environmental purposes, since they do not understand how improvements in environmental quality can be obtained otherwise. That is, environmental taxes are perceived as a pretext for the government to raise new revenues, unless explicit earmarking for environmental purposes is introduced. We use *use of revenues for other purposes* as a second proxy for the understanding of unit pricing's incentive effect. Columns (3) and (4) of Tables C.14 and C.15 display a large and clearly significant coefficient for the treatment. Again, no change affects the control group. As a result, we may infer that following the experience of unit pricing, an important proportion of respondents (at least one fourth applying Greene's correction) becomes aware of the incentive effect of environmental taxes. Looking at Table C.13, we observe that the *ex-post* mean of this variable in the treatment effect attains the level of the control group. The same applies for the variables directly related with perceived effectiveness.

In terms of fairness, we observe whether individuals believe (*ex-ante* and *ex-post*) that unit pricing is unfair based on the following two criteria: 1) households already pay enough taxes; 2) the tax is paid also by households that sort their garbage. We also explore the feeling of inequity, since this type of policy opposes two different concepts of justice, the polluter pays principle, advocating for higher fiscal revenues from bigger polluters, and a social equity principle, stating that fiscal revenues raised from a given individual should be a positive function of its income. Given the regressivity of this type of policy (cf. subsection 3.5.1), the two concepts may be in open conflict, absent any social cushioning or redistribution to households. We thus ask individuals whether they perceive pricing garbage by the bag as inequitable and legitimate and we assess their demand for social cushioning. Tables C.14 and C.15 include these variables.

Columns (5) to (8) reports the estimates for unfairness. Looking at the sign of the coefficients for treatment we observe that experiencing the functioning of unit pricing is related to a lower frequency of answers stating a feeling of unfairness driven by both 1) having to pay new (but not necessarily more) taxes (cf. columns (5) and (6)) and 2) having to pay a price on the residual garbage even after having sorted all materials (cf. columns (7) and (8)). Again, the mechanism behind unit pricing seems to be better understood. Environmental taxes aim at rather modifying behavior than raising new revenues and small polluters are actually rewarded and not punished despite recycling, since they pay relatively less taxes than bigger polluters. It seems that this message partly got through the population along with the treatment. In this respect, the intervention of the Federal price supervisor, who oversees all regulated prices in the

country, might help in making sure (and people aware) that in each municipality lump-sum taxes, for instance, were adapted to offset the new revenues from unit-pricing schemes (cf. SPR 2013). Although the Federal price supervisor is known to give non-binding recommendations, his opinion is considered very influential and usually sufficient to persuade the regulated entity to correct its behavior accordingly.

Columns (9) and (10) present the estimates for the perception of inequitable treatment, while columns (11) and (12) display the estimates for social justice. As opposed to the previous columns, outcomes of columns (9) to (12) do display a significant coefficient for the time dummy, thus suggesting that the debate around the regressivity of pricing garbage by the bag extended to the municipalities in the control group and affected the opinion of their inhabitants. For these variables, the case for a causal interpretation of estimates clearly no longer holds. In both treatment and control groups pricing garbage by the bag is perceived as much less inequitable after January 1st 2013, possibly because this large wave of implementations made individuals much more aware of the regressive impacts that alternative sources of revenues for waste management may have. The debate also highlighted the measures undertaken by municipalities to at least partly offset the possible distributional effects. It does not surprise then, in our opinion, that the tax is perceived as less inequitable but the demand for social cushioning increases (cf. columns (11) and (12)).

In short, experiencing the treatment seems to positively affect the fee's perception, in particular in what concerns its effectiveness and the related sentiments of unfairness associated to an additional tax that is collected also from households practicing recycling. Furthermore, the stigma of social injustice associated to unit pricing is smoothed in the whole Canton, according to the evidence in our sample. This probably happens because the large media coverage at the local level contributed to make clear that policy-induced distributional effects are not an inevitable condition of unit pricing. Sometimes compensation happens mechanically by the reduction of other regressive (e.g. lump-sum) taxes.

Our finding with respect to the fee's perceived effectiveness is consistent with the analysis of OFEFP (2003), which focuses on a bunch of Swiss municipalities and points to a similar gap in the way unit pricing is perceived as effective and workable between municipalities with and without the scheme. Perceived ineffectiveness *ex-ante* is a recurrent argument in the literature and common to environmental taxes in general. It is probably the main reason for the public resistance to revenue-neutral and possibly efficiency-enhancing tax reforms such as environmental tax reforms (ETR). It follows from perceived ineffectiveness that, as in this context, the general public is unwilling *ex-*

ante to make room for a new tax, which is perceived as an additional source of revenue on top of those already existing. Revenue neutrality can hardly be understood, since the tax's environmental purpose cannot be met, for most of the general public, without earmarking. Accordingly, we observe in our data that only *ex-post* a large majority is willing not to earmark revenues for waste management.

These reasons are known to contribute to make subsidies much more popular than taxes. In addition, environmental taxes are perceived as a "punishment", whereas subsidies as a "reward" to a desirable behavior (Steg et al. 2006). Environmental taxes enjoy then a larger support when marketed as *bonus-malus* policies. Arguably, revenue-neutral policies reproduce a sort of *bonus-malus* scheme, but are not understood as such, *ex-ante*. *Ex-post*, we observe instead an important decrease in the feeling of unfairness related to the tax being imposed to the residual garbage. Following the treatment some households may realize that even though they have to buy a positive amount of bags they may still be net winners through a decline in the lump-sum tax. That is, they receive a bonus. This change in perception requires however some salience in the redistribution of revenues. Chapter 2 shows for instance that 60% of Swiss respondents are not aware of the Swiss CO_2 levy on heating fuels, raised since 2008. In such framework, outcomes *ex-post* may be hardly distinguishable from *ex-ante*. In general, these findings suggest the existence of learning costs, which may be addressed *ex-ante* in this and other contexts by e.g. making potential benefits more salient.

3.5.3 Willingness-to-pay

Table 14 reports the estimates for the question on acceptability. We assess acceptability by estimating the willingness-to-pay (WTP) for a 35 liters bag. For simplicity's sake and given that a reference price for the bag already exists, we do not provide a randomized dichotomous choice but a simple scale going from 0 to 5 francs (CHF) with 50-cents intervals. The distribution of bids for 2012 and 2013 is given by Figure C.4. For both years and groups the distribution is not normal and clusters at 0 and 2 (the official price for a 35 liters bag). We can interpret these values in terms of degrees of acceptance, with a value of 0 implying that the tax is clearly disliked, a value of 2 implying that the tax is fine as it is, a value between 0 and 2 implying a demand for a less aggressive taxation whereas people stating a WTP larger than 2 demand some policy tightening. As expected, in 2012 the cumulative distribution function (CDF) for the treatment group lies clearly at the left of the control group's one. That is, lower WTPs are expressed in 2012 in the treatment group compared to the control group.

Instead, CDFs almost completely overlap in 2013, consistent with a common level of acceptability *ex-post*. We thus expect an effect of treatment on acceptability in the regressions.

We display in Table C.16 estimates from both OLS (columns (1) to (3)) and Tobit (columns (4) to (6)) regressions. Columns (2), (3), (5) and (6) include socioeconomic controls, which clearly improve the goodness-of-fit, even though no clear pattern is identified for these variables[10]. We do not show the models in which we control for non-tax policies, since none of them has a significant impact on WTP and the overall goodness-of-fit is only slightly affected. The specifications of columns (3) and (6) control for the main variables discussed in section 3.5.2 and capturing the fee's perception. In all models the coefficient for treatment is positive and significant, robust across specifications both within OLS and Tobit regressions. No significant effect is associated to the time dummy. If interpreted causally, the estimate of column (3) ((6)) indicates that the treatment increases the WTP for a 35 liters bag by about 90 (160) cents. The 90 cents implies an increase of 100% with respect to the mean value in the treatment group (cf. Table C.13). Actually, even the most conservative estimate would allow us to claim that the treatment generates a forceful spur in acceptability.

The variables of columns (3) and (6) only partially contribute to explain this jump in acceptability. Most variables have the expected sign, but only the feeling of unfairness related to having to pay new taxes is strongly negative and significant. This variable seems to capture the perceptional problems discussed in section 3.5.2 and to represent the main obstacle to unit pricing. As discussed, this may be symptomatic of learning costs related to the inexperience of environmental taxes. Yet, the coefficient for the treatment is increased rather than reduced by the inclusion of perception controls. This suggests that we are not able to completely capture the drivers of acceptability. It may well be that the treatment itself keeps a role. Not only it changes the fee's perception, which in turn may affect acceptability, but it also creates a new status-quo to which agents get used. This effect may not be related only to inertial dynamics, but perhaps also to a lag in re-assessing the relative-consumption equilibria (cf. Howarth 2006). With the words of Gowdy (2008, p.641), "[...] the presence of relative consumption effects might inform environmental tax policy. Accounting for such effects reduces the value of individual consumption and increases the willingness to pay for public goods

[10]With respect to students, some professional categories display a recurrent and significant negative sign. These are homemakers, employees, self-employed workers and retired individuals. One may argue that in the case of students, current income may be a particularly bad proxy for permanent income. Yet, it seems that higher WTPs are associated with lower income categories, if anything. From a theoretical perspective, we were not expecting any specific pattern related to income, given the public-good property of waste management (cf. Roca 2003) and the ambiguous net distribution effects.

such as environmental amenities. In terms of implementing this policy, a problem is the time lag between having your income decreased through a tax and realizing much later that your income relative to other is unchanged". Similar "shock" policies have shown to "crowd-in" pro-environmental behavior, for instance when the electricity-mix is all of a sudden made green by default, thus creating a new status-quo supported by a new, "green" social norm.

Overall, the difference in acceptability between *ex-ante* and *ex-post* assessments is consistent with the discussion of section 3.2 and in particular with the findings of Thøgersen (1994). As pointed out, the data at our disposal do not allow us to completely disentangle the behavioral and transactional mechanisms at play. Despite this qualification, we may still identify an important policy implication. The evidence provided in this section suggests that unpopular environmental policy should be given the chance to be tested by the population before being submitted to the population veto. In this sense, we agree with Kallbekken and Sælen (2011) that trial periods may represent a very effective instrument to spur acceptability, as the example of the Stockholm congestion charge seems to prove. Since the policy studied here was endorsed by the Federal Supreme Court of Switzerland, the ultimate advocate of the constitution, we do not have ballot data to support our claim. Anyways, trial periods are not commonly used in Switzerland. Yet, we have to hand curious anecdotal evidence from two villages in the Canton of Vaud, where the population did vote on unit pricing. In the municipality of Moudon the population was asked to vote on a tax rate change, the policy being already in place. Unit pricing remained in place and the higher tax rate was accepted. In the municipality of Gland a unit-pricing scheme was opposed to the status-quo of no scheme. As in the Canton of Jura, the status-quo prevailed.

3.6 Conclusion

We address the question of unit-pricing programs' effectiveness. We provide causal estimates of pricing garbage by the bag's effect on the amount of solid waste incinerated in the Canton of Vaud, Switzerland. Pricing garbage by the bag causes a reduction in the amount of incinerated garbage per capita by about 40%. The identification strategy relies on the forced implementation on January 1st 2013 of pricing garbage by the bag in many municipalities of the Canton of Vaud following a ruling decision by the Federal Supreme Court of Switzerland. Both survey-based household panel data and official data are used. We find that estimates are consistent across datasets. Since some municipalities implemented unit-pricing schemes before January 1st 2013 while

some others managed to postpone their implementation to January 1st 2014, we have at our disposal both already-treated and not-yet-treated control groups. We find that estimates are consistent between control groups. We provide evidence that the amount of solid waste incinerated follow parallel trends in all municipalities, regardless of policy. Yet, the policy determines if municipalities are at a high- or low-garbage steady-state. Once pricing garbage by the bag is implemented, municipalities switch to and remain in a low-garbage equilibrium. Lower incinerated garbage is accompanied by a higher frequency of recycling of e.g. organic waste and aluminum. We do not report any evidence of considerable non-desirable behavior in response to unit pricing.

The estimates provided in this paper, on the contrary of most of the literature, are robust to both endogeneity in the policy choice and simultaneity. Confounders are shown to be related to non-tax policies such as better collection services and awareness-raising campaigns. Neglecting simultaneity is thus likely to lead to biased estimates. On the basis of these results, we argue that pricing gargage by the bag is an effective policy, which may well be justifiable on economic grounds, given also the large externalities associated with solid waste combustion, estimated by Muller et al. (2011) at a level ways above the added value of this sector.

We also address the question of unit-pricing program's acceptability. We identify a clear gap between acceptability *ex-ante* and *ex-post*. Acceptability, measured in terms of willingness-to-pay for priced bag, more than doubles following the implementation of unit pricing. The implementation of unit pricing improves the program's perception of effectiveness and fairness. The incentive effect behind environmental taxes seems to be better understood once the policy is in place. We point to learning cost and behavioral elements to explain this gap. Yet, assessing the determinants of acceptability is by far not an easy task and we clearly do not settle the question. On the contrary, these findings pave the way for a new strand of research in the acceptability of waste taxation.

Postface

Contrary to what standard economic theory presumes, a certain level of cooperation is present in the climate commons (Ostrom 2009). What are the roots of such cooperation? According to Elinor Ostrom, social norms are determinant in spurring cooperation among individuals, in particular by shaping the expectation of cooperation from others and in turn cooperation itself. That is, the environmental bright side of social capital.

Ostrom's legacy consists in a simple, yet powerful, intuition. This thesis discusses Ostrom's intuition, drawing extensively from the model of Nyborg et al. (2006) in an attempt to put into context Ostrom's somewhat "loose" ideas, and provides a first suggestive empirical evidence towards its plausibility. While the evidence presented in this thesis is clearly not conclusive, it has the merit to shed light on a testable hypothesis never tested before. Along with the literature reviewed in this manuscript, it reinforces the belief that individuals may act as conditional cooperators in global dilemmas as in many other, local, situations of life. With no degree of cooperation whatsoever there would be no hope for the climate commons not to turn into a tragedy. Indeed, "once a social system, such as capitalism, convinces everyone that it can dispense with morality and public spirit, the universal pursuit of self-interest being all that is needed for satisfactory performance, the system will undermine its own viability, which is in fact premised on civic behavior and on the respect of certain moral norms to a far greater extent than capitalism's official ideology avows" (Hirschman 1984, p. 94, in reference to Fred Hirsch).

Yet, even some degree of cooperation may not be sufficient to "save the climate". This thesis shows that environmental taxes, even when very effective, face important issues of unpopularity. Unpopularity may then cause effective policies to be smashed even in the presence of a positive demand for environmental protection and climate change mitigation, unless the main obstacles to policy acceptability are addressed head-on in the design and implementation phases of policymaking.

Policymakers should build on this demand and sell acceptable and understandable

policies. In a world of conditional cooperators, probably only a contagious blossoming of unilateral initiatives may give rise to serious and ambitious binding international pledges.

In sum, this thesis addresses the pressing question of how to deal with the global public good which is climate change mitigation and provides the literature with a better understanding of cooperation and policy formation in the environmental arena, bringing to the issue both a touch of optimism, by underlying the importance of social norms, and a touch of pessimism, by recalling the endogeneity of environmental policy and emphasizing the obstacles to its acceptability. With no spirit of cooperation, the future would not look very bright for environmental taxation. There is no surprise though, it always takes two to tango.

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Appendix

A Chapter 1

A.1 Tables

Table A.1: Data sources

Variable	Database	Eurostat table	Measure	Unit
Greenhouse gas emissions	Eurostat	env_air_gge	Greenhouse gas emissions	$10^3$of tons of CO_2 equivalent
GDP per capita	Eurostat	nama_gdp_c	Gross domestic product at current prices	Euro per inhabitant
Trust	World Values Survey	-	Most people can be trusted	Percentage of positive answers
Manufacturing	Eurostat	nama_gdp_c sbs_na_2a_mil	Manufacturing, value added	Percentage of GDP
Imports	Eurostat	nama_exi_c	Imports at current prices	Percentage of GDP
Exports	Eurostat	nama_exi_c	Exports at current prices	Percentage of GDP
Energy	Eurostat	nrg_100a	Gross inland energy consumption	$10^3$of tons of oil equivalent
Population	Eurostat	demo_pjan	Population on January 1^{st}	Number of persons
Deflator	Eurostat	teina110	GDP deflator	Index (2000=100)

Table A.2: Dependent and independent variables: summary statistics

Variable	**Unit**	**Mean**	**Std Dev**	**Min.**	**Max.**	**N**
Greenhouse gas emissions per capita	10^3 tons of CO_2 equivalent	0.011	0.004	0.004	0.035	539
Real GDP per capita	Euros of 2000	19747.18	12622.49	1218.981	71428.57	438
Trust	Share of positive answers	0.352	0.148	0.099	0.68	340
Manufacturing	Share of GDP	0.197	0.056	0.075	0.453	460
Trade openness	Share of GDP	0.494	0.250	0.165	1.764	484
Energy consumption per capita	10^3 tons of oil equivalent	0.004	0.002	0.002	0.014	538

Source: Own computations. See Table A.1 for data sources.

Table A.3: Robustness tests for model (1)

	Greenhouse gas emissions			
	(1)	(2)	(3)	(4)
Trust	-0.242	* (0.140)	* (0.146)	** (0.091)
Real GDP per capita	0.088	** (0.035)	** (0.039)	* (0.044)
Manufacturing	2.241	*** (0.297)	*** (0.376)	*** (0.490)
Trade	-0.569	*** (0.095)	*** (0.100)	*** (0.122)
Constant	-5.080	*** (0.363)	*** (0.384)	*** (0.438)
Standard errors	-	White	Bootstrap	Driscoll-Kraay

Source: Own computations.

Notes: Column (1) provides the coefficients of column (2) in Table 1.1.

Remaining columns show standard errors (in parentheses) as defined in the table.

Driscoll-Kraay standard errors are estimated with default lags, T=18.

*,** and ***: significance at the 90%, 95% and 99% confidence levels, respectively.

Panels are unbalanced. Transition economies are excluded.

B Chapter 2

B.1 Tables

Table B.1: Socioeconomic characteristics: sample's summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Gender (male)	0.521	0.5	0	1	336
Age	36.860	14.04	19	85	336
Years of education	15.782	1.935	11	18	330
Categories of income	4.029	1.816	1	7	239
Labor market (active)	0.949	0.221	0	1	332
Number of adults in the household	2.306	1.194	0	6	337
Number of kids in the household	0.333	0.681	0	4	291
Homeowner	0.223	0.417	0	1	336
Number of cars	1.279	0.957	0	4	337

Table B.2: Environmental attitudes and behavior: summary statistics

Variable	Mean	N
Energy consumption: very attentive	0.2	337
Energy consumption: attentive	0.53	337
Energy consumption: not very attentive	0.22	337
Energy consumption: not attentive at all	0.05	337
Saving energy: to save money	0.77	338
Saving energy: for the environment	0.59	338
Saving energy: other people	0.06	338
Saving energy: other countries	0.06	338
Saving energy: no reasons	0.06	338
Saving energy: the best already	0.07	338
Elastic: gasoline	23.40	292
Elastic: electricity	27.68	297
Elastic: heating fuels	24.59	288
Expected cooperation	0.76	242
Expected foreign cooperation	0.52	247
Government intervention: information	0.73	337
Government intervention: public transportation	0.61	338
Government intervention: taxation	0.35	338
Government intervention: unnecessary	0.03	338
Government intervention: irrelevant	0.02	337
Future prices: gasoline	27	331
Future prices: electricity	16	334
Future prices: heating fuels	18	335
Drivers: climate policy	0.58	337
Drivers: scarcity	0.89	337
Drivers: nuclear exit	0.5	337
Drivers: renewables	0.53	337
Accompanying: awareness	0.63	338
Accompanying: subsidies for all	0.18	338
Accompanying: subsidies for poor	0.25	338
Accompanying: subsidies for rural	0.1	338
Accompanying: rebates for all	0.25	338
Accompanying: rebates for poor	0.25	338
Accompanying: rebates for rural	0.07	338
Accompanying: public transportation	0.62	338

Table B.3: Policy perceptions and acceptability: summary statistics

Variable	Mean	N
Effect on own behavior: less consumption	0.56	338
Effect on own behavior: no change	0.37	338
Effect on own behavior: more consumption	0.07	338
Environmental effectiveness	0.48	338
Co-benefit: better air quality (respondent and society)	0.56	320
Co-benefit: less road congestion (respondent and society)	0.27	320
Co-benefit: better health (respondent and society)	0.42	320
Co-benefit: less road accidents (respondent and society)	0.18	320
Drawback: less purchasing power	0.67	338
Drawback: less comfort	0.34	338
Drawback: fear of losing job	0.05	338
Drawback: none	0.22	338
Drawback: less purchasing power (society)	0.69	338
Drawback: loss of competitiveness	0.20	338
Drawback: distributional effects on the poor	0.46	338
Drawback: rise in unemployment	0.11	338
Acceptability	0.49	338
Social cushioning: low income	0.72	333
Social cushioning: middle income	0.48	333
Social cushioning: high income	0.14	333
Social cushioning: rural	0.35	333
Social cushioning: urban	0.19	333
Social cushioning: large families	0.49	333
Social cushioning: elderly people	0.58	333
Social cushioning: firms	0.24	333
Revenue recycling: social cushioning (first)	0.26	313
Revenue recycling: tax rebates (first)	0.11	313
Revenue recycling: environmental projects (first)	0.60	313
Acceptability when earmarking is specified	0.64	337
Tax rate: 0%	0.13	330
Tax rate: 0-5%	0.30	330
Tax rate: 5-10%	0.31	330
Tax rate: 10-15%	0.16	330
Tax rate: 15-20%	0.05	330
Tax rate: 20-25%	0.02	330
Tax rate: 25-30%	0.02	330

B.2 Questionnaire[11]

A. Energy consumption

1. Do you try to keep your energy consumption under control?

   ☐ Yes, a lot

   ☐ Yes, I do

   ☐ Not really

   ☐ Not at all

2. Do you think that you should consume less energy?
   (multiple answers)

   ☐ Yes, to save money

   ☐ Yes, to help the climate and the environment

   ☐ Yes, if other people do it too

   ☐ Yes, if other countries do it too

   ☐ No, I see no reasons to consume less energy

   ☐ No, I do my best already

3. How much (in %) should the price of the following energy carriers increase to lead you to consume 10% less of it?

   Gasoline: _

   Electricity: _

   Heating fuel: _

4. Do you expect other people in Switzerland to be willing to reduce their energy consumption?

   ☐ Yes

   ☐ No

   ☐ I do not know

[11] The original questionnaires were in French. They are available by the authors upon request.

5. Do you expect other countries to be willing to reduce their energy consumption?

   ☐ Yes

   ☐ No

   ☐ I do not know

6. In your opinion, should the Swiss government intervene to stimulate energy conservation?

   ☐ Yes, by providing information and raising awareness

   ☐ Yes, by subsidizing public transportation

   ☐ Yes, by taxing CO_2 emissions

   ☐ No, this is beyond its scope

   ☐ I do not care of energy conservation

   ☐ I do not know

7. In your opinion, in the next 10 years, the following energy prices will:

Gasoline	Increase of _ (%)	Stay constant	Decrease of _ (%)
Electricity	Increase of _ (%)	Stay constant	Decrease of _ (%)
Heating fuel	Increase of _ (%)	Stay constant	Decrease of _ (%)

8. Which of the following factors do you expect to lead to an increase in energy prices?

	Yes	No	Do not know
Climate policy tightening	☐	☐	☐
Scarcity	☐	☐	☐
Nuclear exit	☐	☐	☐
Expensive renewable energy	☐	☐	☐
Other (please specify)	☐	☐	☐

9. In your opinion, what policy may be needed to cope with higher energy prices? (multiple answers)

   - ☐ Improved communication (e.g. saving tips)
   - ☐ Subsidies for all households
   - ☐ Subsidies for low-income households
   - ☐ Subsidies for rural households
   - ☐ Tax rebates for all households
   - ☐ Tax rebates for low-income households
   - ☐ Tax rebates for rural households
   - ☐ Investments in public transportation
   - ☐ None of these
   - ☐ Other (please specify)

B Carbon tax/Climate contribution

We are now going to ask you a series of questions on a CO_2 tax/climate contribution. This tax/contribution engenders an increase in the price of energy from fossil sources. Imagine a CO_2 tax/climate contribution of 120 CHF/tCO_2 on all fossil fuels, which would imply an increase in the price of gasoline and heating fuels of about 30 cents/liter (more or less 15% of current gasoline price and 30% of current heating oil price).

10. Would this CO_2 tax/climate contribution modify your energy conservation efforts?

    - ☐ Less efforts
    - ☐ No change
    - ☐ More efforts

11. Do you think that this CO_2 tax/climate contribution would allow for a reduction in the amount of energy consumed by the Swiss population?

    - ☐ Yes
    - ☐ No
    - ☐ I do not know

12. What are in our opinion the benefits of a CO_2 tax/climate contribution?
(do not show the answers to respondents, see what they mention spontaneously; multiple answers)

	For you	For the society
Lower CO_2 emissions	☐	☐
Better air quality	☐	☐
Less road congestion	☐	☐
Better health	☐	☐
Less road accidents	☐	☐
None	☐	☐
Other (please specify)	☐	☐

13. What are the drawbacks of this CO_2 tax/climate contribution for your household? (multiple answers)

☐ Loss of purchasing power
☐ Loss of comfort
☐ Fear of losing job
☐ No drawbacks
☐ Other (please specify)

14. What are the drawbacks of this CO_2 tax/climate contribution for the Swiss society?

☐ Loss of purchasing power
☐ Loss of competitiveness
☐ Detrimental effects on low-income households
☐ Higher inequalities between urban and rural areas
☐ No drawbacks
☐ Other (please specify)

15. In spite of drawbacks, is the implementation of such tax/contribution acceptable?

☐ Yes
☐ No
☐ I do not know

16. In your opinion, should the government offset the detrimental effects of such CO_2 tax/climate contribution on the following groups?

	Yes	No
Low-income households (< 50'000 CHF gross/year)	☐	☐
Middle-income households (50'000-100'000 CHF gross/year)	☐	☐
High-income households (> 100'000 CHF gross/year)	☐	☐
Rural households	☐	☐
Urban households	☐	☐
Large families	☐	☐
Elderly people	☐	☐
Firms	☐	☐

17. Please rank in a decreasing order of preference the following ways to use the revenues from the CO_2 tax/climate contribution.

    ☐ Social cushioning in favor of most affected households

    ☐ Tax rebates for households and firms

    ☐ Funding environmental projects, including subsidies to renewable energy

    ☐ Other (please specify)

18. If the revenues from the CO_2 tax/climate contribution were to be used as you indicate in the questions 16 and 17, would you accept this CO_2 tax/climate contribution?

    ☐ Yes

    ☐ No

    ☐ I do not know

19. If in 6 months from now you were asked to vote on a CO_2 tax/climate contribution, what is the price increase in fossil fuels that you would be willing to accept?

    ☐ 0%

    ☐ 0-5%

    ☐ 5-10%

    ☐ 10-15%

    ☐ 15-20%

    ☐ 20-25%

    ☐ 25-30%

    ☐ 30%

20. Does it exist in Switzerland a CO_2 tax on heating fuels?

    ☐ Yes

    ☐ No

    ☐ I do not know

C. General information

21. You are:

    ☐ Female

    ☐ Male

22. Birth year:

23. Postcode:

24. How many people are in your household (including the respondent)?

    Number of adults:

    Number of children (less than 18 years):

25. Currently you are:

    ☐ Homeowner

    ☐ Renter

26. How many cars does your household own?

    ☐ 0

    ☐ 1

    ☐ 2

    ☐ 3

    ☐ 4 or more

27. Are you member of one or more environmental organizations?

    ☐ Yes

    ☐ No

28. In your opinion, protecting the environment is a:

    ☐ Urgent matter

    ☐ Important matter, but not a priority

    ☐ Not urgent at all

29. What is your degree of trust in the Swiss government?

    ☐ Not confident at all

    ☐ Rather not confident

    ☐ Rather confident

    ☐ Completely confident

30. Your current professional status is:

    ☐ Homemaker

    ☐ Student

    ☐ Employee

    ☐ Manager

    ☐ Senior manager

    ☐ Self-employed

    ☐ Retired

    ☐ Jobless

    ☐ Other (please specify)

31. What level of education did you reach? If you are currently studying, please select the level of education corresponding to the highest diploma you already hold.

    ☐ Compulsory schooling

    ☐ Apprenticeship

    ☐ College

    ☐ Professional education

    ☐ University of applied sciences

    ☐ University

32. How would you locate yourself on the left-right axis?

    ☐ Left

    ☐ Center

    ☐ Right

    ☐ No answer

33. What is your household's yearly gross income?

- ☐ <25'000 CHF
- ☐ 25'000-50'000 CHF
- ☐ 50'000-75'000 CHF
- ☐ 100'000-125'000 CHF
- ☐ 125'000-150'000 CHF
- ☐ >150'000 CHF
- ☐ No answer

C Chapter 3

C.1 Figures

Figure C.1: Treatment effect on solid waste per capita in liters per week

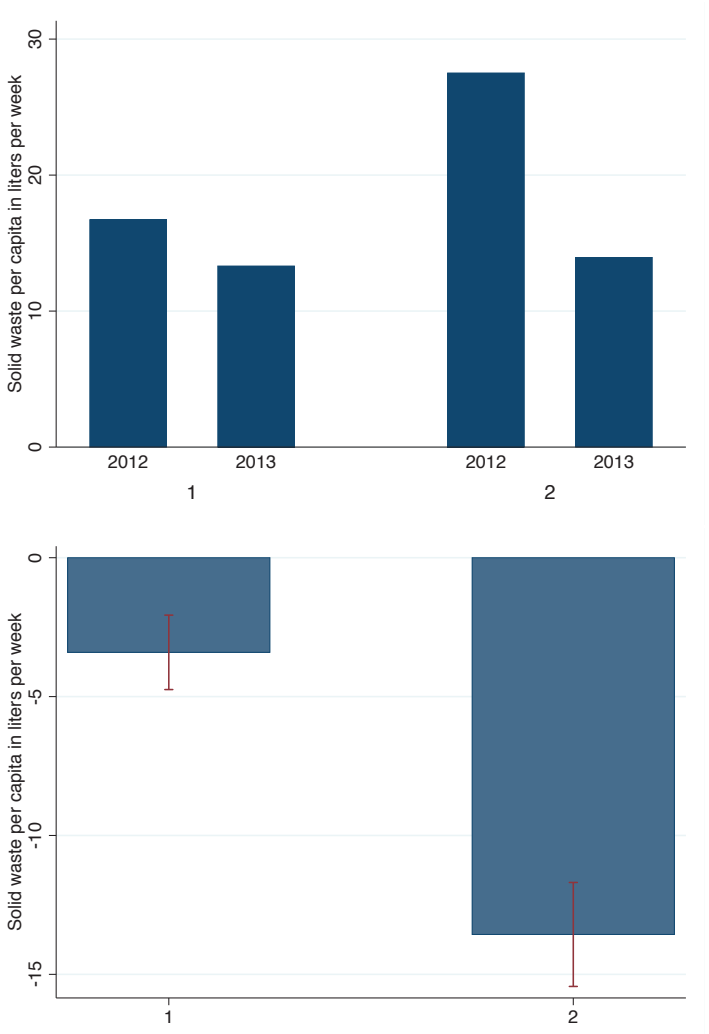


Figure C.2: Parallel trends: treatment and control groups

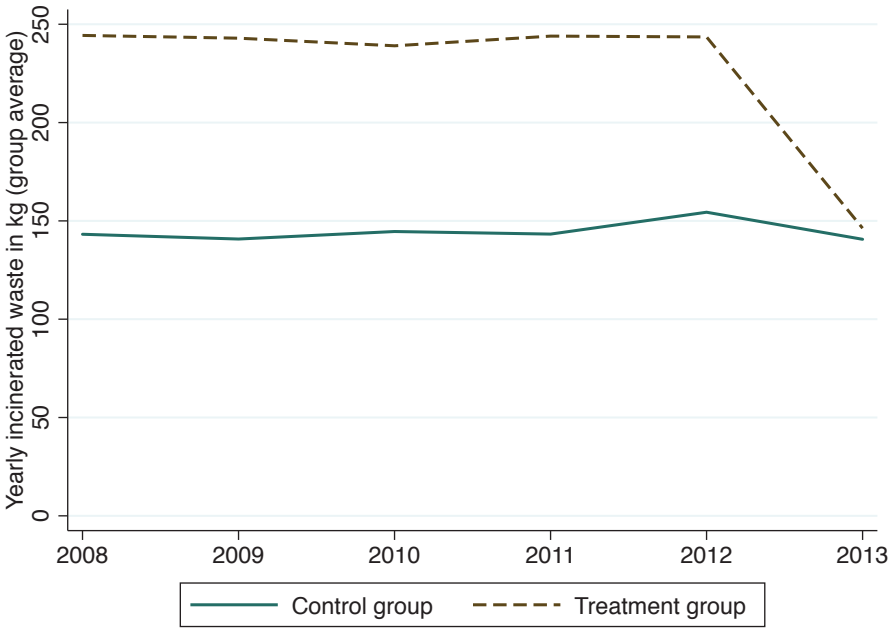


Figure C.3: Parallel trends: extended treatment and control groups

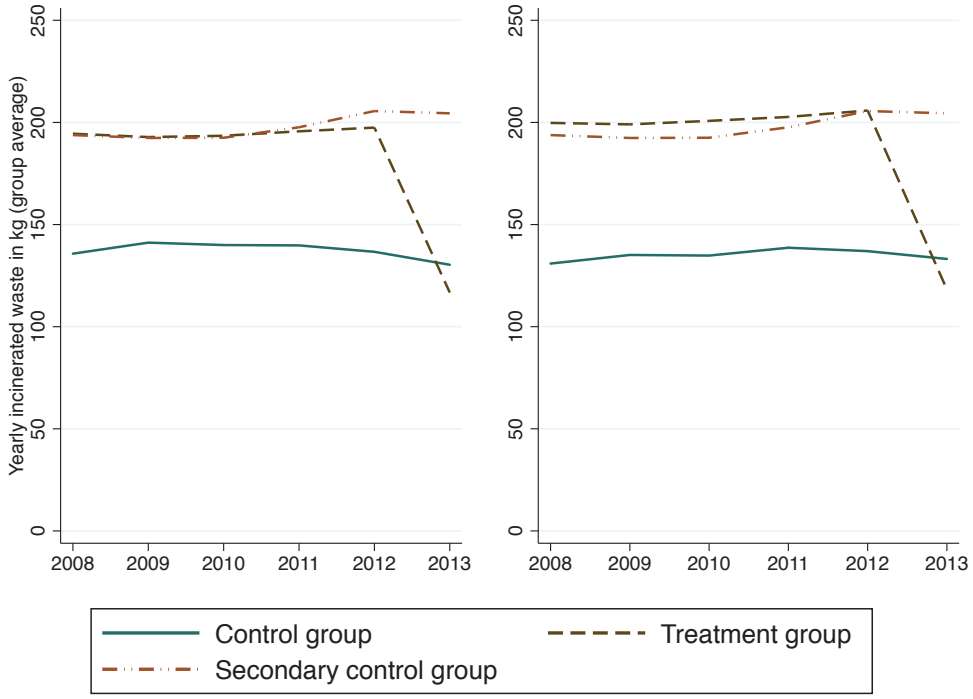
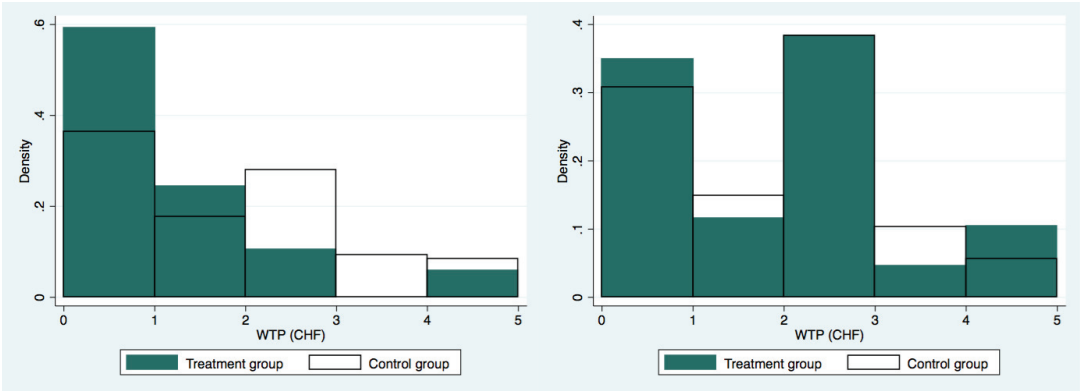


Figure C.4: Willingness-to-pay: frequency of bids



C.2 Tables

TABLE C.1 – Sample's socioeconomic characteristics: mean comparisons and tests

	Interviewed only in 2012		Panel	
	Treatment group	Control group	Treatment group	Control group
Gender (M)	0.41	0.331	0.43	0.327
Age	54.615	58.392	56.395	56.093
Switzerland	0.821	0.842	0.791	0.879
European Union	0.154	0.133	0.186	0.075*
Rest of the world	0.026	0.025	0.023	0.047
Adults in households	2.103	2.042	1.942*	2.131
Children in households	0.974	0.587	0.674*	0.71
Households	38	121	86	107
Total households	159		193	
Compulsory schooling	0.135	0.153	0.070	0.190
Apprenticeship	0.405	0.369	0.477	0.343
High school	0.135	0.234	0.104	0.143**
University	0.324	0.243	0.349	0.324*
Jobless	0.026	0.008	0.023	0
Student	0	0	0	0
Homemaker	0.079	0.084	0.058	0.066
Employee	0.447	0.303	0.384	0.34
Self-employed	0.184	0.151	0.151	0.094*
Manager	0	0.042	0.047*	0.075
Retired	0.237	0.403	0.337	0.387
Income category 1 (<3'000 CHF)	0.026	0.041	0.058	0.075
Income category 2 (3'001-5'000 CHF)	0.051	0.165	0.093	0.168
Income category 3 (5'001-7'000 CHF)	0.103	0.124	0.198*	0.121
Income category 4 (7'001-9'000 CHF)	0.077	0.107	0.163*	0.037**
Income cateory 5 (9'001-15'000 CHF)	0.051	0.041	0.105	0.112*
Income category 6 (>15'001 CHF)	0.051	0.033	0.081	0.065
Missing value for income	0.641	0.488	0.302***	0.421
Distance from collecting center (in minutes)	7.836	5.784	6.368	4.918*
Green	0.135	0	0.093	0
Households	37	116	85	103
Total households	153		188	

Note: *, ** and *** imply statistically-significant differences in the mean for the same group between samples at 10%, 5% and 1%, respectively. No missing values affect the first block of variables (from gender to children in the household). Income is measured as household monthly gross income in Swiss francs (CHF). We also obtain a measure of distance from the closest collecting center (in kilometers and in minutes with the appropriate transport mode) from respondents, which is however not available in the official statistics. To avoid excessive missing values we impute distance in time from distance in space whenever needed and use the former as variable. We qualify as "green" the members of environmental organizations. A measure of general trust as used by the World Values Survey and other large surveys (cf. e.g. Glaeser et al. 2000) is included only in the survey of 2013 and does not allow for comparison between samples. The same applies to the proportion of renters (versus homeowners). Trust is 0.5 in the treatment group and 0.42 in the control group. Renters are 0.34 in the treatment group and 0.33 in the control group.

Table C.2: Canton of Vaud's socioeconomic characteristics

	Cantonal mean
Gender (M)	0.489
Age <20	0.222
Age 20-39	0.276
Age 40-64	0.340
Age >65	0.162
Switzerland	0.682
European Union (EU)	0.230
Rest of the world	0.088
Adults	0.776
Children	0.224
Single-adult households	0.386
Households without children	0.247
Households with children	0.277
Single-member households	0.063
Household size	2.2
Compulsory schooling	0.268
Apprenticeship	0.300
High school	0.091
University	0.321
Jobless	0.049
Student	0.080
Homemaker	0.127
Employee	0.480
Manager	0.065
Retired	0.094
Income <35'000 CHF	0.192
Income 35'001-60'000 CHF	0.220
Income 60'001-80'000 CHF	0.160
Income 80'001-100'000 CHF	0.114
Income 100'001-175'000 CHF	0.207
Income >175'001 CHF	0.107
Renters	0.694

Source: Swiss Federal Statistical Office and Statistique Vaud.

Note: Cantonal statistics refer to years 2012 or 2013 whenever data are available, to year 2011 otherwise. Cantonal data define as children individuals from age 0 to 19. Educational achievements are given only for population over 30 years. The level of education of 2% of the Canton is not know. The share of self-employed workers is not given. Income is measured as yearly gross income in Swiss francs (CHF). The proportion of renters is obtained from the negative of the share of housing assets with owners living in. No measure for trust is available at the Cantonal level. The World Values Survey wave of 2007 reports a level of trust of 0.539 for Switzerland. More recent data are available from the European Social Survey, which however uses a 10 points scale instead of a binary variable as in our survey.

Table C.3: Solid waste production, recycling and attention to voluminous wrapping: comparison between 2012 and 2013

	2012						2013					
	Treatment group			Control group			Treatment group			Control group		
Variable	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N
Per capita	27.385	19.229	85	16.187	10.618	103	13.875***	12.821	85	13.153**	12.987	98
Per household	65.906	46.203	85	39.728	30.946	103	33.647***	40.698	85	35.061	32.634	98
PET	0.919	0.275	86	0.981	0.136	107	0.953	0.212	86	0.944*	0.231	107
Carton	0.849	0.36	86	0.944	0.231	107	0.965***	0.185	86	0.907*	0.292	107
Paper	0.895	0.308	86	0.972	0.166	107	0.953**	0.212	86	0.935	0.248	107
Clothes	0.872	0.336	86	0.897	0.305	107	0.907	0.292	86	0.841	0.367	107
Cans	0.733	0.445	86	0.925	0.264	107	0.756	0.432	86	0.738***	0.442	107
Organic waste	0.698	0.462	86	0.85	0.358	107	0.884***	0.322	86	0.841	0.367	107
Batteries	0.942	0.235	86	0.935	0.248	107	0.988**	0.108	86	0.897	0.305	107
Aluminum	0.733	0.445	86	0.907	0.292	107	0.93***	0.256	86	0.869	0.339	107
Attention to wrapping	0.471	0.502	85	0.551	0.500	107	0.571*	0.498	84	0.608	0.490	102

Note: *, ** and *** imply statistically-significant differences in the mean for the same group between years at 10%, 5% and 1%, respectively.

Table C.4: Treatment effect on solid waste per capita in liters per week

	(1)		(2)	
Year 2013	-2.847**	(1.184)	-2.845**	(1.360)
Pay-per-bag fee	-10.51***	(1.921)	-9.668***	(2.009)
Gender (M)			-2.192	(2.079)
Age			-0.0904	(0.0783)
EU			4.012*	(2.319)
Rest of the world			-1.745	(4.424)
Adults in households			-5.644***	(1.453)
Children in households			-1.465	(1.023)
Apprenticeship			-2.626	(2.515)
High school			-2.275	(3.738)
University			-8.055***	(2.496)
Jobless			-1.462	(12.73)
Homemaker			-11.32	(12.36)
Employee			-8.208	(11.23)
Self-employed			-6.783	(10.45)
Manager			-8.632	(12.55)
Retiree			-10.36	(11.60)
Green			-0.159	(3.440)
Renter			-2.110	(1.822)
Distance			0.268*	(0.142)
Income category 1			-18.40***	(3.487)
Income category 2			-2.309	(3.972)
Income category 3			-5.919*	(3.282)
Income category 4			-5.629	(3.868)
Income category 5			0.733	(3.956)
Income is missing			-7.642**	(3.242)
Constant	21.23***	(0.467)	56.12***	(12.70)
Within-R^2	0.117		0.295	
N	371		359	

Note: Clustered standard errors in parentheses (cluster per municipality).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.5: Recycling: effect of treatment on the treated, counterfactual and treatment effect

Material	Observed effect	Counterfactual	Treatment effect
PET	=	-	+
Carton	+	=	+
Paper	+	-	+
Clothes	=	=	=
Glass	+	=	+
Cans	=	-	+
Organic waste	+	=	+
Batteries	+	=	+
Aluminum	+	=	+
Wrapping	=	=	=

Note: + (-) indicate a positive (negative) effect. = is used when the effect is not different from zero.

Table C.6: Treatment effect on recycling and wrapping (OLS)

	Aluminum				Battery				Carton			
	(1)		(2)		(3)		(4)		(5)		(6)	
Year 2013	-0.0374	(0.0401)	-0.00107	(0.0423)	-0.0374	(0.0403)	0.0192	(0.0373)	-0.0374	(0.0391)	0.00331	(0.0360)
Pay-per-bag fee	0.235***	(0.0718)	0.195**	(0.0745)	0.0839	(0.0519)	0.0288	(0.0511)	0.154**	(0.0652)	0.107	(0.0656)
Gender (M)			-0.0174	(0.0545)			0.0110	(0.0330)			0.0176	(0.0298)
Age			0.00130	(0.00184)			0.00143	(0.00145)			0.0000438	(0.00130)
EU			-0.0716	(0.0541)			-0.0823**	(0.0371)			-0.00425	(0.0376)
Rest of the world			0.109	(0.0892)			-0.0256	(0.0877)			0.0846	(0.0591)
Adults in households			0.0186	(0.0240)			-0.0267	(0.0268)			-0.0140	(0.0247)
Children in households			-0.0293	(0.0261)			-0.00880	(0.0146)			-0.0279	(0.0186)
Apprenticeship			-0.0120	(0.0644)			0.00162	(0.0546)			-0.00998	(0.0492)
High school			-0.0479	(0.0685)			-0.00507	(0.0560)			-0.00834	(0.0436)
University			0.0853	(0.0621)			0.0345	(0.0543)			-0.00229	(0.0510)
Jobless			0.330	(0.222)			-0.232**	(0.0928)			-0.102	(0.113)
Homemaker			0.278	(0.217)			-0.128	(0.0905)			-0.0445	(0.102)
Employee			0.235	(0.193)			-0.203***	(0.0712)			-0.124*	(0.0728)
Self-employed			0.251	(0.188)			-0.225***	(0.0835)			-0.182**	(0.0802)
Manager			0.239	(0.228)			-0.238**	(0.0944)			-0.125	(0.0944)
Retiree			0.222	(0.206)			-0.240**	(0.0954)			-0.160*	(0.0874)
Green			0.0431	(0.0646)			-0.00454	(0.0421)			0.0518	(0.0509)
Distance			-0.00205	(0.00476)			0.0000173	(0.00316)			-0.00520*	(0.00306)
Renter			0.0245	(0.0444)			0.00867	(0.0296)			-0.0228	(0.0371)
Income category 1			0.110	(0.119)			-0.00924	(0.0730)			0.108	(0.103)
Income category 2			0.109	(0.0942)			-0.00115	(0.0619)			0.119*	(0.0620)
Income category 3			0.0884	(0.0913)			0.0653	(0.0665)			0.0629	(0.0847)
Income category 4			0.0101	(0.0800)			0.0228	(0.0493)			0.0181	(0.0698)
Income category 5			-0.0275	(0.102)			-0.0222	(0.0561)			-0.0195	(0.0615)
Income is missing			0.0315	(0.0723)			-0.0124	(0.0557)			0.0945*	(0.0532)
Constant	0.829***	(0.0173)	0.460**	(0.222)	0.938***	(0.0133)	1.117***	(0.137)	0.902***	(0.0159)	1.055***	(0.128)
Within-R^2	0.047		0.101		0.009		0.059		0.0258		0.088	
N	386		368		386		368		386		368	

Note: Clustered standard errors in parentheses (cluster per municipality).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Clothes				Glass				Organic waste			
	(7)		(8)		(9)		(10)		(11)		(12)	
Year 2013	-0.0561	(0.0487)	-0.00975	(0.0542)	-0.0187	(0.0295)	0.0281	(0.0180)	-0.00935	(0.0509)	0.0369	(0.0470)
Pay-per-bag fee	0.0910	(0.0683)	0.0335	(0.0766)	0.0885*	(0.0443)	0.0206	(0.0355)	0.195***	(0.0695)	0.144**	(0.0645)
Gender (M)			0.0232	(0.0552)			-0.00934	(0.0192)			0.0818*	(0.0487)
Age			0.00223	(0.00208)			0.000986	(0.000857)			0.00507**	(0.00218)
EU			-0.0850	(0.0611)			-0.0218	(0.0265)			-0.0414	(0.0664)
Rest of the world			0.0643	(0.120)			-0.156**	(0.0726)			0.00972	(0.171)
Adults in households			-0.0290	(0.0367)			-0.0195	(0.0218)			0.0160	(0.0353)
Children in households			-0.0126	(0.0271)			0.00483	(0.0106)			-0.00117	(0.0274)
Apprenticeship			-0.00251	(0.0615)			0.0212	(0.0353)			-0.0853	(0.0525)
High school			-0.0121	(0.0737)			0.00932	(0.0298)			-0.137*	(0.0784)
University			0.0573	(0.0584)			0.0303	(0.0330)			0.0162	(0.0598)
Jobless			-0.320***	(0.115)			0.0649	(0.111)			-0.0926	(0.282)
Homemaker			-0.130	(0.123)			0.158	(0.117)			-0.0111	(0.316)
Employee			-0.283***	(0.0967)			0.0712	(0.107)			0.0892	(0.261)
Self-employed			-0.322***	(0.0986)			0.0533	(0.109)			-0.00952	(0.265)
Manager			-0.352**	(0.160)			0.0574	(0.109)			0.106	(0.271)
Retiree			-0.298**	(0.113)			0.0478	(0.107)			0.0118	(0.262)
Green			-0.0106	(0.0701)			0.0149	(0.0228)			0.0143	(0.0674)
Distance			-0.00677*	(0.00352)			-0.00438**	(0.00212)			-0.0208***	(0.00485)
Renter			-0.0162	(0.0486)			0.00813	(0.0223)			0.0446	(0.0456)
Income category 1			0.0639	(0.123)			0.0256	(0.0489)			0.135	(0.128)
Income category 2			0.0795	(0.103)			-0.0415	(0.0616)			0.0748	(0.0969)
Income category 3			0.147*	(0.0869)			0.00454	(0.0687)			-0.0716	(0.123)
Income category 4			0.0778	(0.0946)			0.0534	(0.0532)			0.00856	(0.106)
Income category 5			0.0103	(0.0949)			0.0128	(0.0511)			-0.159	(0.125)
Income is missing			0.0795	(0.0796)			0.0362	(0.0516)			-0.00912	(0.102)
Constant	0.886***	(0.0172)	1.070***	(0.206)	0.948***	(0.0110)	0.871***	(0.152)	0.782***	(0.0176)	0.567	(0.363)
Within-R^2	0.006		0.069		0.017		0.133		0.032		0.166	
N	386		368		386		368		386		368	

Note: Clustered standard errors in parentheses (cluster per municipality).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Paper				PET				Wrapping			
	(13)		(14)		(15)		(16)		(17)		(18)	
Year 2013	-0.0374	(0.0321)	0.00225	(0.0228)	-0.0374	(0.0291)	0.00447	(0.0183)	0.0558	(0.0612)	0.0577	(0.0682)
Pay-per-bag fee	0.0955*	(0.0528)	0.0361	(0.0531)	0.0723	(0.0475)	0.00896	(0.0412)	0.0497	(0.0914)	0.0561	(0.0987)
Gender (M)			-0.0190	(0.0223)			0.0128	(0.0188)			-0.129*	(0.0736)
Age			0.00377***	(0.00126)			0.00182*	(0.00100)			0.00367	(0.00279)
EU			-0.00865	(0.0328)			-0.0277	(0.0337)			-0.179*	(0.105)
Rest of the world			0.0440	(0.0665)			-0.0234	(0.0853)			0.160	(0.146)
Adults in households			0.0235	(0.0206)			-0.0166	(0.0169)			-0.0868*	(0.0480)
Children in households			0.000532	(0.0120)			0.0217**	(0.0108)			-0.0382	(0.0377)
Apprenticeship			-0.0179	(0.0399)			-0.00308	(0.0327)			-0.0674	(0.103)
High school			0.0318	(0.0420)			0.0453	(0.0291)			-0.0892	(0.116)
University			0.0393	(0.0394)			0.00968	(0.0327)			0.0428	(0.0979)
Jobless			-0.0362	(0.0465)			-0.0661	(0.0785)			0.0870	(0.248)
Homemaker			-0.0443	(0.0523)			-0.0621	(0.0632)			0.181	(0.249)
Employee			-0.120**	(0.0481)			-0.108	(0.0651)			0.166	(0.149)
Self-employed			-0.126**	(0.0578)			-0.123*	(0.0691)			0.123	(0.152)
Manager			-0.114*	(0.0602)			-0.0676	(0.0746)			0.410*	(0.225)
Retiree			-0.143**	(0.0689)			-0.0987	(0.0727)			0.213	(0.160)
Green			0.0599*	(0.0302)			0.0381	(0.0274)			0.0697	(0.0988)
Distance			-0.00642**	(0.00250)			-0.00421*	(0.00250)			-0.00541	(0.00773)
Renter			0.00529	(0.0297)			0.0303	(0.0255)			-0.0363	(0.0753)
Income category 1			0.0850	(0.0610)			0.0768	(0.0829)			0.487***	(0.182)
Income category 2			0.0550	(0.0679)			0.0493	(0.0781)			0.205	(0.152)
Income category 3			0.0655	(0.0772)			0.165**	(0.0760)			0.201	(0.130)
Income category 4			0.0611	(0.0522)			0.108	(0.0688)			0.625***	(0.120)
Income category 5			-0.00134	(0.0627)			0.0657	(0.0690)			0.00950	(0.167)
Income is missing			0.0192	(0.0596)			0.111*	(0.0608)			0.330**	(0.126)
Constant	0.938***	(0.0129)	0.798***	(0.106)	0.953***	(0.0116)	0.886***	(0.130)	0.514***	(0.0224)	0.191	(0.299)
Within-R^2	0.012		0.112		0.008		0.093		0.008		0.222	
N	386		368		386		368		378		365	

Note: Clustered standard errors in parentheses (cluster per municipality).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.7: Treatment effect on recycling and wrapping (Probit)

	(1) Aluminum	(2) Battery	(3) Carton	(4) Clothes	(5) Glass	(6) Organic waste	(7) Paper	(8) PET	(9) Wrapping
Year 2013	-0.0666	-0.0823	-0.0801	-0.0788	-0.0636	-0.00724	-0.119	-0.143	0.0704
	(0.0778)	(0.0993)	(0.0845)	(0.0733)	(0.108)	(0.0951)	(0.110)	(0.116)	(0.0744)
Pay-per-bag fee	0.271***	0.216***	0.218***	0.116	0.205***	0.238***	0.197**	0.183**	0.0538
	(0.0611)	(0.0590)	(0.0489)	(0.0796)	(0.0698)	(0.0784)	(0.0810)	(0.0916)	(0.109)
Pseudo-R^2	0.118	0.076	0.096	0.055	0.096	0.099	0.064	0.072	0.084
N	234	120	184	250	112	246	144	136	343

Note: Estimates report marginal effects (all discrete changes). Brute force fixed effects.

Individuals bypassed if Y_{ict} always =0 or always =1 (fixed effects cannot be computed).

Clustered standard errors in parentheses (cluster per municipality). Standard errors computed with the Delta method (cf. Greene 2011).

* $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$.

Table C.8: Non-tax waste management policies undertaken between 2012 and 2013: descriptive statistics

	Treatment group		Control group	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
New skip: paper	0.117	0.323	0.043	0.204
New skip: carton	0.064	0.246	0.06	0.239
New skip: PET	0.17	0.378	0.043	0.204
New skip: clothes	0.117	0.323	0.06	0.239
New skip: glass	0.17	0.378	0.043	0.204
New skip: cans	0.117	0.323	0.043	0.204
New skip: batteries	0.117	0.323	0.043	0.204
New skip: aluminum	0.064	0.246	0.043	0.204
New skip: plastic	0.085	0.281	0	0
New skip: wood	0	0	0.017	0.131
New skip: organic waste	0.117	0.323	0.138	0.346
New skips: number of materials covered	1.138	2.754	0.534	1.867
New collection center	0.064	0.246	0.043	0.204
Collection centers: better opening hours	0.223	0.419	0.155	0.364
New curbside program	0.074	0.264	0.034	0.183
Awareness-raising campaign: unaddressed mailshot	0.5	0.503	0.345	0.477
Awareness-raising campaign: information session	0.117	0.323	0	0
Awareness-raising campaign: street stand	0.021	0.145	0	0
Awareness-raising campaign: specific website	0	0	0.017	0.131
N	94		116	

Table C.9: Treatment effect on solid waste per capita in liters per week (non-tax policies)

	(1)	(2)	(3)
Year 2013	-1.777	-2.692	-2.894
	(1.904)	(3.299)	(3.241)
Pay-per-bag fee	-12.20***	-11.08***	-10.89***
	(3.129)	(3.762)	(3.763)
New skips: number of materials covered		-1.340**	-1.305**
		(0.606)	(0.615)
Collection centers: better opening hours		6.104	5.970
		(4.170)	(4.258)
New curbside program		-9.383	-9.451
		(6.330)	(6.490)
New collection center		6.918**	7.213**
		(2.690)	(2.720)
Awareness-raising campaign: unaddressed mailshot		0.647	0.699
		(4.462)	(4.456)
Constant	21.71***	21.68***	30.67***
	(0.765)	(0.748)	(4.912)
Socio-economic variables	No	No	Yes
Within-R^2	0.105	0.115	0.153
N	205	205	205

Note: Clustered standard errors in parentheses (cluster per municipality).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.10: Treatment effect on solid waste per capita in kilos per year (official data, survey sample, non-tax policies)

	(1)	(2)	(3)
Year 2013	-11.15**	-7.579**	-6.619
	(4.346)	(3.407)	(7.496)
Pay-per-bag fee	-86.14***	-84.80***	-82.73***
	(12.26)	(16.25)	(19.86)
New skips: number of materials covered			-0.110
			(2.669)
Collection centers: better opening hours			-16.00
			(13.81)
New curbside program			17.04
			(14.27)
New collection center			12.49*
			(6.282)
Awareness-raising campaign: unaddressed mailshot			1.356
			(10.01)
Constant	173.6***	178.7***	178.7***
	(2.380)	(3.012)	(3.062)
Within-R^2	0.715	0.724	0.737
N	116	68	68

Note: Robust standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.11: Treatment effect on solid waste per capita in kilos per year (official data, extended samples)

	Standard control group		Secondary control group
	(1)	(2)	(3)
Year 2013	-8.487***	-7.969***	-10.20***
	(3.178)	(2.748)	(3.233)
Pay-per-bag fee	-80.03***		-78.31***
	(4.380)		(4.418)
Unit pricing		-79.78***	
		(4.064)	
Constant	186.6***	181.3***	201.4***
	(1.179)	(1.117)	(1.109)
Within-R^2	0.828	0.822	0.804
N	434	470	500

Note: Robust standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.12: Income elasticity: income effect on solid waste per capita (in logs)

	Solid waste per capita (log)
Income (log)	0.395***
	(0.104)
Within-R^2	0.471
N	205

Note: Clustered standard errors in parentheses (cluster per municipality).

Controlling for time, treatment and socio-economic variables.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.13: Acceptability and policy perception: comparison between 2012 and 2013

		2012						2013					
		Treatment group			Control group			Treatment group			Control group		
Variable	Short	Mean	St. Dev.	N	Mean	St. Dev.	N	Mean	St. Dev.	N	Mean	St. Dev.	N
Effect on own behavior	Eff. own	0.419	0.496	86	0.411	0.494	107	0.547**	0.501	86	0.383	0.488	107
Effectiveness	Effectiveness	0.784	0.414	74	0.839	0.37	93	0.928***	0.261	69	0.878	0.329	90
Effect on the environment	Eff. env.	0.581	0.496	86	0.736	0.443	106	0.721**	0.451	86	0.71	0.456	107
Effect on waste management	Eff. waste	0.221	0.417	86	0.34	0.476	106	0.419***	0.496	86	0.421	0.496	107
Use of revenues for other purposes	Use rev.	0.262	0.442	84	0.689	0.465	106	0.709***	0.457	86	0.71	0.456	107
Polluter-pays: awareness	Pp aware	0.837	0.371	86	0.85	0.358	107	0.907*	0.292	86	0.869	0.339	107
Polluter-pays: agreement	Pp agree	0.698	0.462	86	0.916	0.279	107	0.779	0.417	86	0.804***	0.399	107
Polluter-pays: applied by the fee	Pp applied	0.674	0.471	86	0.736	0.443	106	0.721	0.451	86	0.692	0.464	107
Unfair: inequitable	Unfair ineq.	0.233	0.425	86	0.208	0.407	106	0.07***	0.256	86	0.065***	0.248	107
Unfair: paying enough taxes	Unfair taxes	0.547	0.501	86	0.302	0.461	106	0.349***	0.479	86	0.262	0.442	107
Unfair: paying even if sorting	Unfair sort	0.558	0.5	86	0.34	0.476	106	0.349***	0.479	86	0.383	0.488	107
Legitimacy despite regressive effects	Leg. reg.	0.570	0.498	86	0.308	0.464	107	0.679*	0.47	81	0.745***	0.438	102
Legitimacy provided social cushioning	Leg. cush.	0.353	0.481	85	0.286	0.454	105	0.558***	0.5	86	0.561***	0.499	107
More acceptable if base is federal	Federal	0.488	0.503	86	0.623	0.487	106	0.44	0.499	84	0.535	0.501	101
Willingness-to-pay	WTP	0.878	1.183	86	1.491	1.478	107	1.552***	1.489	86	1.574	1.297	107

Note: *, ** and *** imply statistically-significant differences in the mean for the same group between years at 10%, 5% and 1%, respectively.

Table C.14: Policy perception: effect of the pay-per-bag fee's implementation in the treatment group (OLS)

	(1) Eff. env.	(2) Eff. env.	(3) Use rev.	(4) Use rev.
Year 2013	-0.0251	-0.0268	0.0188	0.0155
	(0.0602)	(0.0633)	(0.0519)	(0.0566)
Pay-per-bag fee	0.165*	0.203**	0.421***	0.458***
	(0.0899)	(0.0968)	(0.0780)	(0.0831)
Constant	0.667***	1.225***	0.502***	0.495*
	(0.0224)	(0.378)	(0.0195)	(0.272)
Socio-economic variables	No	Yes	No	Yes
Within-R^2	0.013	0.119	0.116	0.214
N	385	368	383	365

	(5) Unfair taxes	(6) Unfair taxes	(7) Unfair sort	(8) Unfair sort
Year 2013	-0.0376	-0.00346	0.0439	0.0925
	(0.0486)	(0.0530)	(0.0583)	(0.0658)
Pay-per-bag fee	-0.160*	-0.208**	-0.253***	-0.312***
	(0.0801)	(0.0838)	(0.0910)	(0.0977)
Constant	0.410***	0.617	0.437***	0.397
	(0.0196)	(0.473)	(0.0225)	(0.423)
Socio-economic variables	No	Yes	No	Yes
Within-R^2	0.028	0.181	0.026	0.142
N	385	368	385	368

	(9) Unfair ineq.	(10) Unfair ineq.	(11) Leg. cush.	(12) Leg. cush.
Year 2013	-0.144***	-0.118***	0.273***	0.248***
	(0.0413)	(0.0440)	(0.0557)	(0.0597)
Pay-per-bag fee	-0.0186	-0.0375	-0.0671	-0.00935
	(0.0749)	(0.0780)	(0.0896)	(0.0937)
Constant	0.219***	0.239	0.316***	0.479
	(0.0181)	(0.337)	(0.0221)	(0.370)
Socio-economic variables	No	Yes	No	Yes
Within-R^2	0.057	0.114	0.070	0.181
N	385	368	383	365

Note: Clustered standard errors in parentheses (cluster per municipality). Cluster standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C.15: Policy perception: effect of the pay-per-bag fee's implementation in the treatment group (Probit)

	(1) Eff. env.	(2) Eff. env.	(3) Use rev.	(4) Use rev.
Year 2013	-0.0328	-0.0346	0.0304	0.0321
	(0.0819)	(0.0851)	(0.0759)	(0.0887)
Pay-per-bag fee	0.174*	0.221**	0.440***	0.497***
	(0.0945)	(0.0930)	(0.0715)	(0.0662)
Socio-economic variables	No	Yes	No	Yes
Pseudo-R^2	0.088	0.192	0.187	0.297
N	337	324	333	314

	(5) Unfair taxes	(6) Unfair taxes	(7) Unfair sort	(8) Unfair sort
Year 2013	-0.0565	0.00372	0.0560	0.134
	(0.0753)	(0.0885)	(0.0749)	(0.0865)
Pay-per-bag fee	-0.190*	-0.295***	-0.274***	-0.363***
	(0.102)	(0.0934)	(0.0939)	(0.0929)
Socio-economic variables	No	Yes	No	Yes
Pseudo-R^2	0.164	0.312	0.105	0.199
N	326	311	355	342

	(9) Inequitable	(10) Inequitable	(11) Leg. cush.	(12) Leg. cush.
Year 2013	-0.242***	-0.188***	0.311***	0.308***
	(0.0665)	(0.0668)	(0.0629)	(0.0690)
Pay-per-bag fee	-0.0179	-0.0492	-0.0918	-0.0202
	(0.119)	(0.0964)	(0.102)	(0.113)
Socio-economic variables	No	Yes	No	Yes
Pseudo-R^2	0.167	0.263	0.127	0.217
N	249	236	374	356

Note: Estimates report marginal effects (all discrete changes). Brute force fixed effects.

Individuals bypassed if Y_{ict} always =0 or always =1 (fixed effects cannot be computed).

Clustered standard errors in parentheses (cluster per municipality).

Standard errors computed with the Delta method (cf. Greene 2011). * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$.

Table C.16: Acceptability: willingness-to-pay for a 35-liters bag

	(1)	(2)	(3)	(4)	(5)	(6)
Model	OLS	OLS	OLS	Tobit	Tobit	Tobit
Year 2013	0.0841	0.0552	0.139	0.153	0.136	-0.680**
	(0.173)	(0.186)	(0.391)	(0.278)	(0.279)	(0.289)
Pay-per-bag fee	0.590***	0.671***	0.892**	0.944**	1.059***	1.630***
	(0.206)	(0.224)	(0.343)	(0.370)	(0.377)	(0.445)
Effect on the environment			0.207			0.454
			(0.164)			(0.275)
Use of revenues for other purposes			-0.285			-0.282
			(0.216)			(0.334)
Unfair: inequitable			0.0204			0.0734
			(0.177)			(0.310)
Unfair: paying enough taxes			-0.452***			-0.862***
			(0.148)			(0.263)
Unfair: paying even if sorting			-0.263			-0.371
			(0.165)			(0.271)
Legitimacy provided social cushioning			0.107			0.240
			(0.154)			(0.223)
Constant	1.218***	2.456***	1.460	0.0806	1.799	0.472
	(0.0541)	(0.734)	(0.902)	(0.151)	(1.098)	(1.105)
Socio-economic variables	No	Yes	Yes	No	Yes	Yes
Within-R^2	0.033	0.177	0.320			
Pseudo-R^2				0.076	0.125	0.178
N	386	368	205	386	368	353

Note: Clustered standard errors in parentheses (cluster per municipality). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

C.3 Questionnaires[12]

Survey of 2012

1. Does your households sort the following materials?
   (multiple answers)

   - PET bottles
   - Carton
   - Paper
   - Clothes
   - Glass
   - Cans
   - Organic waste
   - Batteries
   - Aluminum

2. Do you pay attention to wrapping while shopping?

   - Yes
   - No

3. Would you generate less incinerated garbage if:
   (multiple answers)

   - Collection centers were closer to you
   - Collection centers were better developed
   - You were imposed a fee on all non-sorted garbage
   - You could not do better, you already sort all what can be sorted

4. a. How many bags does your household fill with garbage every week?

   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

4. b. Bags volume

   - 17 liters
   - 35 liters

[12]The original questionnaires were in French. They are available by the authors upon request.

5. Pricing garbage by the bag is implemented in your municipality. Can you indicate the price for a 17-/35-liters bag?
(if applicable)

5. Pricing garbage by the bag is not implemented in your municipality. Do you know whether its implementation is planned in the foreseeable future?
(if applicable)

   - Yes
   - No

6. If you would be asked to vote on the fee's rate, what is the highest price you would accept to pay for a 35-liters bag?
(please select the value that is closer to your preferences, in CHF)

   - 0
   - 0.50
   - 1
   - 1.50
   - 2
   - 2.50
   - 3
   - 3.50
   - 4
   - 4.50
   - 5

7. a. Does the pay-per-bag fee incite you to sort more?
(if applicable)

   - Yes, you sort more
   - No, you already sorted all what can be sorted
   - No, the fee does not affect your behavior
   - No, you sort less, since you pay the fee you can generate so much garbage as you want

7. a. Would a pay-per-bag fee incite you to sort more than what you currently sort?
(if applicable)

   - Yes, you would sort more
   - No, you already sort all what can be sorted
   - No, the fee would not affect your behavior
   - No, you would sort less, since you would pay the fee you could generate so much garbage as you want

7. b. Would a higher fee incite you to sort more?
   (if applicable, if the third answer is selected)

   - Yes
   - No

8. Does the pay-per-bag fee incite you to pay more attention to volominuous wrapping while shopping?
   (if applicable)

   - Yes
   - No

8. Would the pay-per-bag fee incite you to pay more attention to volominuous wrapping while shopping?
   (if applicable)

   - Yes
   - No

9. Do you consider the pay-per-bag fee as legitimate?

   - Yes
   - No, I am against taxing garbage
   - No, I am against all new taxes
   - I do not know

10. In your opinion, the pay-per-bag fee:
    (multiple answers)

    - Allows for the application of the polluter-pays principle
    - Contributes to the quality of the environment
    - Lowers the waste management costs
    - Favors high-income households and is thus inequitable
    - Makes you paying even if you already sort your garbage
    - Is unfair because you already pay enough taxes
    - Is useless, since it does not change people's behavior

11. The pay-per-bag fee could imply a higher expenditure for low-income households:
    - In spite of this, you think that the fee is legitimate
    - You think that the fee is legitimate provided that low-income households are compensated
    - This fact does not influence your opinion on the pay-per-bag fee
12. Do you consider the pay-per-bag fee as effective, in the sense that it incites the inhabitants of your municipality to recycle more of their garbage and pay more attention to voluminous wrapping?
    - Yes
    - No
    - You do not know
13. Would you accept a pay-per-bag fee whose revenues would be used to fund some public expenditures other than waste management, such as education, safety?
    - Yes, what is important is that what is paid depends on the amount of garbage incinerated and that the polluter-pays principle is applied
    - Yes, so that your municipality can afford to finance other projects thanks to the fee's revenues
    - No, I think that the pay-per-bag fee's must be used to finance the management of waste only
    - No, I am against the fee anyway
14. The pay-per-bag fees applies the polluter-pays principle, in the sense that the costs of waste management are paid by those responsible for those costs in a proportion corresponding to the amount of garbage generated, and not passed to the community as a whole. In your case:
    (one element at the time, start with knowledge of the principle)
    - You knew this principle
    - You did not know this principle
    - You agree with this principle
    - You do not agree with this principle
    - You do not have any opinion on this principle

15. Would you accept more easily a pay-per-bag fee if it would be adopted everywhere in Switzerland?

    - Yes
    - No

Socio-economic characteristics

16. Gender

    - Female
    - Male

17. Municipality

18. Age

19. Of how many people is your household composed? Adults?

20. Children?

21. Nationality

    - Switzerland (specify canton of birth)
    - European Union (specify country)
    - Other (specify country)

22. What is the highest level of education that you attained?

    - Compulsory schooling
    - Apprenticeship
    - Post-compulsory schooling
    - Tertiary education

23. What is your current professional profile?

    - Homemaker
    - Student
    - Employee
    - Manager
    - Self-employed
    - International civil servant
    - Jobless
    - Retired

24. In your opinion, protecting the environment is...

    - A urgent issue
    - An important issue but there are other priorities
    - Not an issue
    - An issue that does not concern me

25. Are you a member of an environmental organization?
    (participating financially is a sufficient condition)

    - Yes
    - No

26. a. Could you estimate the distance between your residence and the closest collection center?
    (in minutes, with the usual transportation mode)

27. b. Could you estimate the distance between your residence and the closest collection center?
    (in kilometers, approximating)

28. What is the monthly gross income of your household?

    - $<$ 3'000 CHF
    - 3'001-5'000 CHF
    - 5'001-7'000 CHF
    - 7'001-9'000 CHF
    - 9'001-15'000 CHF
    - $>$ 15'001 CHF
    - No answer

Survey of 2013

1. Does your households sort the following materials?
   (multiple answers)

   - PET bottles
   - Carton
   - Paper
   - Clothes
   - Glass
   - Cans
   - Organic waste
   - Batteries
   - Aluminum

2. Do you pay attention to wrapping while shopping?

   - Yes
   - No

3. Would you generate less incinerated garbage if:
   (multiple answers)

   - Collection centers were closer to you
   - Collection centers were better developed
   - You were imposed a fee on all non-sorted garbage
   - You could not do better, you already sort all what can be sorted

4. a. How many bags does your household fill with garbage every week?

   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

4. b. Bags volume

   - 17 liters
   - 35 liters

5. Pricing garbage by the bag is implemented in your municipality. Can you indicate the price for a 17-/35-liters bag?

6. If you would be asked to vote on the fee's rate, what is the highest price you would accept to pay for a 35-liters bag?
   (please select the value that is closer to your preferences, in CHF)

   - 0
   - 0.50
   - 1
   - 1.50
   - 2
   - 2.50
   - 3
   - 3.50
   - 4
   - 4.50
   - 5

7. Does the pay-per-bag fee incite you to sort more?

   - Yes, you sort more
   - No, you already sorted all what can be sorted
   - No, the fee does not affect your behavior
   - No, you sort less, since you pay the fee you can generate so much garbage as you want

8. Do you consider the pay-per-bag fee as legitimate?

   - Yes
   - No, I am against taxing garbage
   - No, I am against all new taxes
   - I do not know

9. In your opinion, the pay-per-bag fee:
   (multiple answers)

   - Allows for the application of the polluter-pays principle
   - Contributes to the quality of the environment
   - Lowers the waste management costs
   - Favors high-income households and is thus inequitable
   - Makes you paying even if you already sort your garbage
   - Is unfair because you already pay enough taxes
   - Is useless, since it does not change people's behavior

10. The pay-per-bag fee could imply a higher expenditure for low-income households:
    - In spite of this, you think that the fee is legitimate
    - You think that the fee is legitimate provided that low-income households are compensated
    - This fact does not influence your opinion on the pay-per-bag fee
11. Do you consider the pay-per-bag fee as effective, in the sense that it incites the inhabitants of your municipality to recycle more of their garbage and pay more attention to voluminous wrapping?
    - Yes
    - No
    - You do not know
12. Would you accept a pay-per-bag fee whose revenues would be used to fund some public expenditures other than waste management, such as education, safety?
    - Yes, what is important is that what is paid depends on the amount of garbage incinerated and that the polluter-pays principle is applied
    - Yes, so that your municipality can afford to finance other projects thanks to the fee's revenues
    - No, I think that the pay-per-bag fee's must be used to finance the management of waste only
    - No, I am against the fee anyway
13. The pay-per-bag fees applies the polluter-pays principle, in the sense that the costs of waste management are paid by those responsible for those costs in a proportion corresponding to the amount of garbage generated, and not passed to the community as a whole. In your case:
    (one element at the time, start with knowledge of the principle)
    - You knew this principle
    - You did not know this principle
    - You agree with this principle
    - You do not agree with this principle
    - You do not have any opinion on this principle

14. Would you accept more easily a pay-per-bag fee if it would be adopted everywhere in Switzerland?

    - Yes
    - No

Socio-economic characteristics

15. Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?

    - Most people can be trusted
    - You can never be too careful when dealing with others

16. Municipality

17. Are you:

    - Renter
    - Homeowner

18. In your opinion, protecting the environment is...

    - A urgent issue
    - An important issue but there are other priorities
    - Not an issue
    - An issue that does not concern

19. Are you a member of an environmental organization?
    (participating financially is a sufficient condition)

    - Yes
    - No

Survey to the municipalities

1. Municipality
2. Between 2012 and 2013, how many (if any) new collection centers were introduced in your municipality?
3. Between 2012 and 2013, did your municipality introduce new skips for the following materials?

   - PET bottles
   - Carton
   - Paper
   - Clothes
   - Glass
   - Cans
   - Organic waste
   - Batteries
   - Aluminum
   - Plastics
   - Other (specify)

4. Between 2012 and 2013, were the opening hours of the collection centers in your municipality prolonged?

   - Yes
   - No

5. Between 2012 and 2013, did your municipality implement a system of curbside collection for the following materials?

   - PET bottles
   - Carton
   - Paper
   - Clothes
   - Glass
   - Cans
   - Organic waste
   - Batteries
   - Aluminum
   - Plastics
   - Other (specify)

6. Between 2012 and 2013, did your municipality launch any awareness-raising campaign with the aim of spurring recycling such as:

   - Information sessions
   - Street stands
   - Advertising
   - Other (specify)