Essays on Incentives and Pro-Environmental Behaviour

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Declaration

I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree. Chapter 2 was co-authored with Florence Kondylis, Development Research Group, World Bank; and Astrid Zwager, Development Research Group, World Bank. Specifically, I was provided the baseline data as secondary data. I designed and conducted the empirical analysis and the write-up, however, the co-authors developed the contingent valuation instrument, full survey, and collected the data. The co-authors also significantly helped with final revisions. The paper was published in *Public Finance Review* in 2015 (see De Martino et al. (2015)). The appendix paper was co-authored with Stefano Pagiola, Environment and Natural Resources Global Practice, World Bank; Florence Kondylis, Development Research Group, World Bank; and Astrid Zwager, Development Research Group, World Bank. Same as in Chapter 2, the analysis was conducted by myself, but the data was provided as secondary data from the co-authors. Chapter 3 was co-authored with Liana O. Anderson, National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN); Torfinn Harding, Department of Economics, NHH Norwegian School of Economics, and University of Stavanger; Karlygash Kuralbayeva, Grantham Research Institute, LSE; Andre Lima, Department of Geographical Sciences, University of Maryland. Andre Lima created the data for our team from high resolution satellite imagery. Karlygash Kuralbayeva led and authored the theoretical framework for the paper (which is not included in this dissertation). I worked with and under Torfinn Harding's guidance on the empirical strategy and econometric analysis. Chapters 4 and 5 were co-authored with Kerri Brick, Environmental Policy Research Unit (EPRU), University of Cape Town; Martine Visser, School of Economics, University of Cape Town. Martine Visser led our team and the policy dialogue with the City of Cape Town (CoCT) which enabled us to conduct a randomised control trial in collaboration with CoCT. While it was an independent research question for this thesis to specifically test the effect of extrinsic incentives such as social recognition on intrinsic motivation, the team collectively designed the empirical strategy to test the hypothesis as well as many other theories in behavioural economics. We collectively designed all treatment arms, implemented the RCT, and analysed the data.

Signature:

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Summary

This thesis consists of four self-contained essays at the nexus of applied microeconomics, behavioural economics, and environmental economics. In the essays of the thesis, I use field experiments and econometric tools to examine the impact of monetary and non monetary incentives for behavioural change during resource scarcity. I use methods of eliciting intrinsic motivations and then empirically test theories on the interaction of intrinsic motivation and extrinsic incentives. Specifically I analyse whether and which incentives undermine, support, or are independent of existing preferences, and whether incentives change behaviour.

The first two essays analyse two distinct types of conservation policy in Brazil: i) direct payments from the state of São Paulo to small landholders living in vulnerable ecosystems conditional on the landholders conserving their land; and, ii) federal policy to regulate, monitor and enforce land use in the Brazilian Amazon through conservation zoning and creation of a public list of municipalities with high rates of deforestation ("priority municipalities") to increase visibility and thus accountability.

The first essay[1] uses a field experiment in Brazil to test if monetary incentives to conserve land on private property in vulnerable ecosystems - "Payments for Environmental Services" (PES) - crowd out demand for a conservation program. Landholders are less likely to accept the higher monetary offers to conserve compared to the lowest offers. Given that the rational choice model does not explain the role of incentives in shaping demand for PES, we then look at the interaction of the randomised incentive offers and individuals' initial intrinsic motivations. We construct methods to elicit social preferences in order to analyse this interaction. We find that, while high monetary incentives crowd in demand of progovernment landholders, they crowd out demand of pro-environment (henceforth "proenvironment") and prosocial landholders.

The second essay[2] combines satellite data on deforestation with data on the location and timing of the conservation zones in Brazil to estimate the effect of conservation zoning on deforestation in the period 2004-2010. We provide spatial regression discontinuity estimates and difference-in-difference estimates to show that

[1]Co-authors: Florence Kondylis, Development Research Group, World Bank; Astrid Zwager, Development Research Group, World Bank.

[2]Co-authors: Liana O. Anderson, National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN); Torfinn Harding, Department of Economics, NHH Norwegian School of Economics, and University of Stavanger; Karlygash Kuralbayeva, Grantham Research Institute, LSE; Andre Lima, Department of Geographical Sciences, University of Maryland.

the policy does not explain the large reduction in deforestation rates during this period. We provide evidence that zones reduce deforestation in municipalities put on a federal government "shame" list for high deforestation rates.

The last two essays[3] test behavioural interventions to decrease residential water consumption across the City of Cape Town in South Africa as complements to tariff increases and water restrictions during a severe water crisis. Using inserts in monthly municipal bills, we test multiple behavioural messages in a randomised control trial on the full population of free standing domestic households (400 000+). The treatments are classified into five groups: information provision and increased salience on the tariff structure, financial savings, appeals to the public good, social comparison, and social recognition. By using a number of different framings, the third essay focuses on identifying which incentives best motivate individuals of different income levels to reduce their consumption. We find that lower income households respond only to financial incentives, whereas the higher income households respond only to social incentives and appeals to their intrinsic motivation.

In the final essay, we further explore the drivers behind the effect of social recognition on pro-environmental behaviour (henceforth "proenvironment behaviour"). According to Bénabou and Tirole (2006), the visibility of doing-good may create doubt to others as to the true motive of the individual and result in a crowding out of prosocial behaviour. We use three treatments within the larger randomised control trial to disentangle intrinsic motivation, extrinsic incentives, and image motivation. We exogenously vary the visibility of the social recognition treatments to test whether i) social recognition incentives crowd out intrinsic motivation and, ii) whether social recognition increases the noise of the prosocial signal and ultimately crowds out cooperation. We find, on average, using image motivation as an extrinsic incentive crowds in cooperation. Social recognition with an explicit opt-out has, on average, no effect on consumption. Thus, in our setting, the signal of social recognition for prosocial behaviour is strong enough to elicit cooperation. In application to public policy, our findings suggest public recognition can be used as an adjunct to more traditional demand side management tools, such as water restrictions and tariff increases to achieve additional conservation in the higher income households. To our knowledge, this empirical analysis has not been executed elsewhere and contributes both to the academic literature as well as policy recommendations for alternatives to traditional demand side management tools during times of resource scarcity.

[3]Co-authors: Kerri Brick, Environmental Policy Research Unit (EPRU), University of Cape Town; Martine Visser, School of Economics, University of Cape Town.

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Almost tantamount to the intellectual challenge, this PhD has been an emotional test of endurance and isolation. While I walked this path alone, there were many people who walked alongside for times and offered the love and support I needed to keep going. This process wouldn't have begun without my pact with Lorenz. You have often been my backbone through your continued friendship and support. I'm grateful to my Sussex tribe for intellectual, technical and emotional support, as well as witty humor and cooked meals together: Eva, Hector and Sarah, Ani, Cecilia, Antonia, Marco, Amrita, Elsa, Javi, Edgar, Egidio, Mattia, Rashaad, Tseguy, Nihar, Farai, and the rest of the wonderful PhD community. I'm grateful for my Cape Town/UCT family: Meg, Emily, Clare, Nic and Asmsus. Thank you Graham for reminding me to be a human and enjoy life. And thanks to my decades-old friends who have remained my support network: Laura, Maura, Jill, Amanda, and Ingrid.

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Chapter 1

Introduction

Conservation of natural resources is imperative for the sustainability of human development on this planet. Recognised by the United Nations in its 2030 agenda for sustainable development, which formulates 17 Sustainable Development Goals (SDGs)[1], conservation is one of the goals necessary to achieve "sustainable development in its three dimensions - economic, social and environmental - in a balanced and integrated manner." (United Nations, 2015)

Yet conservation often yields greater benefits to society than to the individual, driving a wedge between private marginal benefits and collective societal benefit. While it is recognised that conservation is needed on an aggregate level, conservation in practice suffers from the public goods dilemma: independent of each individual's contribution, all share the benefits equally. Thus, the incentive is to free ride (Hardin, 1968; Hasson et al., 2010; Brekke and Johansson-Stenman; Brick et al., 2016b). Consequently, incentives are needed to promote conservation in the presence of these externalities. Against this background, it is crucial that incentives which facilitate the adoption of conservation practices at the individual and household level be identified and validated via rigorous impact evaluations. And while most interventions have high costs both in overhead and implementation, low cost

[1] See Sustainable Development Goal (SDG) 14 ("conserve and sustainably use the oceans, seas and marine resources for sustainable development") and 15 ("protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss")(United Nations, 2015).

and non punitive interventions to promote conservation have not been fully designed and tested.

The overarching question of this thesis is "what are the incentives for individuals to conserve the environment?". In economics, rational choice explains behaviour (Friedman, 1953); individuals maximise personal advantage given their constraints. To incentivise behavioural change, rewards and sanctions can be used to change these trade-offs (Olson, 1965; Ostrom, 1997). Prosocial behaviour, such as conservation of natural resources, may be encouraged through rewards such as monetary (Chapter 2) and non monetary incentives (Chapter 4 and 5). Antisocial behaviour may be discouraged through sanctions such as regulation and enforcement (Chapter 3).

For some, extrinsic incentives may not be necessary to achieve a socially optimal outcome. Cognitive psychologists found that an activity can be rewarding of its own, independent of any external reward or sanction; this is called intrinsic motivation (Deci, 1971) or the "warm glow" effect (Andreoni, 1990). Solow (1971) assumed monetary incentives were synergetic to behaving altruistically. However, this is not always the case: extrinsic incentives - and monetary incentives in particular - may reduce intrinsic motivation (Deci and Ryan, 1985; Lane, 1991; Andreoni, 1990; Bénabou and Tirole, 2003; Bénabou and Tirole, 2006).

Thus, for those who are intrinsically motivated, the effect of an extrinsic incentive to behave prosocially - i.e. conserving natural resources - is an empirical question. Frey (1992) introduced the possibility of an external incentive crowding out intrinsic motivation into a simple rational choice model. An individual may perceive that the external instrument is used to control or regulate the individual's intrinsic motivation; it diminishes self determination and therefore welfare. Alternatively, the external instrument may be interpreted as a recognition by the principal that the agent is behaving well, raising their self evaluation and thus welfare. Frey and Oberholzer-Gee (1997) argue that in the case of environmental policy in particular, monetary incentives need to be reconsidered as they may crowd in or out "civic duty".

The channel through which incentives affect behaviour are largely determined by how the individual perceives the incentive supporting or undermining their intrinsic motivation (Frey, 1992). Throughout the thesis, I explore whether monetary and non monetary incentives support, undermine, or are independent of intrinsic motivations. In particular, I analyse the effect of various incentives on conservation behaviour: monetary incentives, social norms, public recognition, appeals to contribute to the public good, and information provision.

The first two essays analyse two distinct types of conservation policy in Brazil: i) direct payments from the State of São Paulo to small landholders living in vulnerable ecosystems conditional on the landholders conserving their land; and, ii) federal policy to regulate, monitor and enforce land use in the Brazilian Amazon through the creation of conservation areas. In addition we look at the impact of a Federal "shame" list of municipalities with high deforestation rates.

If individuals are self-interested profit maximizing rational individuals, then increasing the private financial gains from conservation should incentivise behavioural change. To analyse the effects of monetary incentives to promote prosocial behaviour, I look at demand for Payments for Environmental Services (PES) in Chapter 2. Recently, payments to landholders, conditional on them preserving forest on their private land (PES), are being used in critical ecological areas to incentivise the landowner to change current land use. PES programs resulting in low rates of change in deforestation are hypothesised to be due to either a) spillage, or b) high enrolment of those who are already motivated to conserve their land resulting in low or no additionality of land conserved (Sierra and Russman, 2006; Pfaff et al., 2008). Inefficient targeting of PES projects may altogether jeopardise the impact of PES projects (Sánchez-Azofeifa et al., 2007; Pfaff et al., 2008) and compromise taxpayer dollars. Using a field experiment in the state of São Paulo, Brazil, we find demand for a PES incentives program is non monotonic in price. Given the rational choice model does not fully explain demand, we explore the interaction of incentives and preexisting intrinsic motivations. We find that while high monetary incentives crowd in demand for progovernment landholders, they crowd out demand of proenvironment and prosocial landholders.

A vastly different conservation policy in Brazil is land use regulation and enforcement. In Chapter 3, we estimate the effect of conservation zoning and enforcement in the Brazilian Amazon to explain the large decrease in deforestation in the 2000s. By combining satellite data on deforestation with data on the location and timing of the conservation zones in Brazil, we estimate the effect of conservation zoning on deforestation in the period 2004-2010. We provide spatial regression discontinuity estimates and difference-in-difference estimates to show that the land regulation does not explain the large reduction in deforestation rates during this period. Rather, we find evidence that zones reduce deforestation if located in a municipality put on a "shame" list by the federal government for having high rates of deforestation. The visibility increases accountability; these municipalities were subject to more rigorous environmental monitoring and law enforcement from Brazil's environmental protection agency (IBAMA) as well as possible sanctions.

As an alternative to providing monetary incentives or sanctions and regulations, insights from behavioural economics suggest that individuals can be motivated to change behaviour by non monetary extrinsic incentives. In the provision of public utilities, municipalities resort to pecuniary approaches (i.e. tariff hikes) or structural approaches (i.e. water restrictions) during time of resource scarcity to correct for market failures. Experiencing severe drought, local municipalities throughout South Africa have been implementing both types of instruments to reduce water consumption. Assuming individuals are profit maximizing rational individuals, price mechanisms or structural adjustments should incentivise resource efficiency through the cost benefit tradeoff. However, tariff structures are often not salient nor easily understood. Thus shifting behaviour through tariff changes is rendered less effective by the complex tariff which dilutes the price signal (Brick et al., 2016a). Shifting behaviour through structural adjustments is often regressive as lower income households are less able to adjust their behaviour through uptake of resource efficient technology.

Non monetary behavioural interventions can be low cost and scalable and are appropriate across the income spectrum. However the exact mechanisms underlying behavioural change in water or energy conservation due to non monetary behavioural interventions are not fully understood in the literature to-date due to multiple channels coalescing into the treatment effect (Allcott, 2011; Ferraro et al., 2011; Ayres, 2010). In Chapters 4 and 5, we investigate the role of framing in addition to existing pecuniary measures as determinants for proenvironmental behaviour change in South Africa (specifically, household water conservation).

In Chapter 4, we empirically test hypotheses postulated in behavioural economics theory to identify the causal chain underlying the incentives driving behavioural change to conserve. We aim to measure if households respond most strongly to salience on the tariff pricing structure, financial incentives, appeals to their intrinsic motivation, social norms, social recognition, or appeals to contribute to the public good.

Using inserts in monthly household utility bills, we test seven behavioural messages in a randomised control trial on the entire population of free standing households in the Western Cape, South Africa (412 489 households) to disentangle the channels through which households are motivated to reduce water consumption. We find that lower income households respond only to information provision on the tariff structure and how to save money, whereas the higher income households respond only to intrinsic motivation and social incentives.

In Chapter 5, we tease out the social recognition treatments in more detail. Revealing identity to reward prosocial behaviour has been used in to increase voting, charity contributions and blood donations (Gerber et al. (2008); Lacetera et al. (2011), qtd. in Samek and Sheremeta (2015)). Yet the causal mechanisms through which social recognition promotes prosocial behaviour is noisy- especially if individuals behave prosocially exclusively for the reward. Bénabou and Tirole (2006) hypothesise that the signal of doing-good may cast doubt on the true motive of the behaviour: heterogeneity in the individual's image motivation can increase the noise-to-signal ratio and dampen the overall net effect.

We empirically test Bénabou and Tirole's (2006) hypotheses by disentangling intrinsic motivation, extrinsic incentives, and image motivation. More specifically, we test whether i) extrinsic incentives crowd out intrinsic motivation and, ii) whether social recognition obscures the signal of prosocial behaviour and ultimately crowds-out cooperation. The social recognition incentive is publishing the name and suburb of all households who met a reduction target during our treatment period on the City of Cape Town's website. We test (ii) by exogenously varying the visibility of the social recognition: we allow an explicit opt-out for one treatment arm. Applying the results to theory (Bénabou and Tirole, 2006; Frey, 1992), we find, on average, using image motivation as an extrinsic incentive crowds in cooperation. However, in our income quintile analysis, we discover that this effect is only picked up in the middle to high income households. In our setting, we find the signal of compulsory social recognition for prosocial behaviour is strong enough to elicit cooperation in wealthy households. Yet, because the social recognition with an explicit opt-out has no effect on consumption, we hypothesise that the effect we pick up in the compulsory social recognition treatment ("image motivation" treatment) might be due to the avoidance of shame. As we did not conduct a "shaming" treatment due to ethical concerns, we leave this area for future research. In application to public policy, our findings suggest that, for the higher income population, image motivation can be used as an adjunct to more traditional demand side management tools, such as water restrictions and tariff increases to achieve additional conservation. Importantly, the effect is only observed in the middle to high income quintiles which are the households who use the most water and are least responsive to price signals (Brick et al., 2016a).

Contributions of this thesis are multi-fold. It provides a critical evaluation of both bottom-up (Chapter 2) and top-down (Chapter 3) carrot and stick policy levers to promote conservation of scarce resources. With the collaboration of co-authors, the thesis creates new data using high resolution satellite imagery (Chapter 3) and city-wide administrative data on utilities (Chapter 4 and Chapter 5) as public goods. The thesis also utilises advanced econometric techniques including factor analysis and separately, geospatial analysis combined with regression discontinuity methods and difference-in-differences to critically evaluate policy interventions.

Crucially, it contributes to the behavioural economics literature by separating and empirically testing multiple behavioural science theories through a city-wide randomised control trial (Chapter 4 and Chapter 5). The behavioural theories which have been empirically tested to-date in the literature are situated in developed countries. Furthermore, many of the studies focus on the impact of social norms on behaviour change, and often the interventions include other potential channels which have not yet been causally evaluated, such as information provision and financial savings (Allcott, 2011; Ferraro et al., 2011; Ayres, 2010). We contribute to this literature by finding that social norms do impact behaviour, however, other factors are at play. Specifically, financial incentives and social recognition are stronger drivers of behavioural change. Importantly, we find vastly different mechanisms affect behavioural change across income groups in a highly unequal country. This is a key finding as budget constrained governments are often seeking effective, low-cost, demand-side and non-punitive conservation policies. Thus a significant contribution of this thesis is empirical evidence on the cost-effectiveness of government using behavioural incentives for conservation of scarce resources in a developing country context suffering from environmental crises and egregious inequality.

The rest of the thesis is structured as follows: Chapter 2 uses a field experiment to test the interaction of a monetary incentive and pre existing intrinsic motivations on demand for a PES program in Brazil. Chapter 3 empirically tests the effect of land use regulation and enforcement on deforestation in the Brazilian Amazon. Chapter 4 uses a randomised field experiment in the City of Cape Town to causally determine which incentives work best to promote water conservation across all domestic households. Chapter 5 teases out one of the channels - social recognition

- to determine if the extrinsic incentive crowds out intrinsic motivation. Chapter 6 summarises the overall findings, discusses their limitations, and provides avenues for further research.

Chapter 2

Protecting the Environment: For Love or Money? *The Role of Motivation and Incentives in Shaping Demand for Payments for Environmental Services Programs*[1]

2.1 Introduction

In neoclassical economics, rational choices based on the benefits and costs of alternative actions explain behaviour. Carrots (rewards) and sticks (sanctions) can alter behaviour by affecting these trade-offs. Offering monetary rewards to perform a certain action will increase the benefits relative to its costs and thus make the action more likely. In the context of environmental issues, policies have recently

[1]Co-authors: Florence Kondylis, Development Research Group, World Bank; Astrid Zwager, Development Research Group, World Bank. This research was funded by the Spanish Fund for Latin America and the World Bank Brazil Country Management Unit. A version has been published in *Public Finance Review* in 2015 (see De Martino et al. (2015)

been designed to nudge agents to internalise the societal cost of degradation and adopt environmentally desirable behaviour through subsidy programs, commonly known as payment for environmental services (PES). The underlying assumption of PES programs is that monetary rewards provide *extrinsic* motivation to conserve the environment by influencing the cost-benefit analysis that determines behaviour.

However, the pure rational choice paradigm has increasingly been called into question by behavioural economics, which allows for alternative motivations for individual action. In particular, individuals' actions may respond to *intrinsic motivations* independently of external (or extrinsic) incentives (Deci and Ryan, 1985). In the realm of environmental policies, individuals may have varying levels of intrinsic motivation to protect the environment. Critically, the effect of extrinsic monetary incentives can depend on individuals' intrinsic motivations. For example, a number of studies in the economics and psychology literature suggest a crowding out effect whereby monetary incentives may actually *reduce* intrinsic motivation to behave a certain way (Frey, 1992; Bénabou and Tirole, 2003). Frey (1992) shows that, as individuals perceive a policy as an external instrument to control or regulate intrinsic motivation, it may diminish their self determination and, therefore, welfare associated with ecological behaviour. On the other hand, intrinsic and extrinsic motivations may act as complements, and offering higher levels of subsidy may leverage preinstalled conservation behaviour (*crowding-in*). Agents may interpret the subsidy payments as recognition of "good" behaviour, raising their self-evaluation and welfare derived from conservation Frey and Oberholzer-Gee (1997).

Another mechanism through which monetary incentives may undermine conservation is framing. Evidence from the lab suggests that external incentives may shift an individual's decision from a social frame to a monetary frame (Heyman and Ariely, 2004); once the framing on the activity changes, the level of the monetary incentive matters above and beyond the intrinsic motivations, suggesting that levels of conservation may in fact decrease after the phasing out of a PES program (Gneezy and Rustichini, 2000; Lepper and Greene, 2015).

The literature thus suggests that the impact of a monetary incentive on conservation behaviour is a priori ambiguous and may be conditioned by preexisting levels of intrinsic motivations. Monetary incentives to increase conservation of private land may not have the effect expected under rational choice accounts.

We contribute to this literature by shedding light on the interplay of extrinsic and intrinsic motivations in the context of a payments for environmental services (PES) program. In the PES literature, many studies have analyzed land and demographic characteristics of participants in the programs (Sierra and Russman, 2006; Rios and Pagiola, 2010; Pagiola et al., 2010; Arriagada et al., 2009; Pfaff et al., 2008; Robalino et al., 2008), yet the role of intrinsic motivation in the context of demand for PES has not been thoroughly studied. One exception is a recent paper by Zanella et al. (2014) who use ex post data to show that information, environmental concern, and participation positively affect take up of PES programs in Brazil. We are not aware of any studies that analyze the interaction of extrinsic and intrinsic incentives in the context of demand for PES programs.

Using an experiment in Brazil, we vary extrinsic incentives by randomising hypothetical offers to landholders in vulnerable watersheds to conserve and/or restore trees surrounding springs on their land[2]. We capture intrinsic motivations through a detailed survey instrument on individual preferences regarding the environment and society. In an earlier working paper (see Appendix B for full paper), we used factor analysis to construct latent indices which allowed us to develop a taxonomy of intrinsic motivations to conserve. We use the constructed indices of latent motivations in this essay. Our findings suggest that, contrary to rational-actor expectations, demand for conservation and restoration programs does not increase with higher subsidies. Landholders who took part in our experiment were randomly assigned to four offer levels and asked a double-bounded contingent valuation question to elicit a hypothetical willingness to accept (WTA) value. We find that landholders are less likely to accept the payment if they were randomly assigned to the high offer

[2] The CV data used in this thesis is secondary data.

treatments than if they were randomly assigned to the low offer treatments.

Our analysis of the interaction of extrinsic and intrinsic motivations suggests that monetary incentives can undermine intrinsic motivation in certain cases, making individuals less likely to accept a PES program. Specifically, we found that while high monetary incentives elicit higher demand for conservation behaviour among prolegal and progovernment landholders, they crowd-out demand of proenvironment and prosocial landholders. This crowding-out effect explains why progressively higher monetary offers did not increase landowners' likelihood to accept. From a policy perspective, this result suggests that program administrators should, to the extent possible, take individual motivation into consideration when designing PES programs. This is particularly important for ensuring that such policies have *additionality*, since we find those who are compliant to existing conservation laws are those accepting the payments.

Our study builds on a new strand of field experiments that seek to analyze the interaction of motivation and incentives in relation to environment protection (Vollan, 2008; Kerr et al., 2012). Using trust and common pool resource games in South Africa and Namibia, Vollan (2008) finds that a monetary incentive's crowding-out effect on prosocial behaviour is dependent on three conditions: strong existing norms of trust and reciprocity; a low degree of self-determination in the individual; and perceptions of the external regulation as controlling rather than supportive. Kerr et al. (2012) run lab-in-the-field experiments to isolate the impact of incentives on weekend volunteerism in Mexico and Tanzania. In Mexico, group payments made through village authorities resulted in lower participation where people distrust leaders (Kerr et al., 2012). Payments did not undermine participation in Tanzania, but they reduced satisfaction from the task.

However, our results must be taken lightly as the monetary incentive- while correctly randomized - may not have captured the true valuation of the landholder due to instrument design issues. Specifically, the monetary offers were too narrow in value. For example, while we know that landholders were less likely to accept the incentive if in the highest bid treatment, we cannot know if they might have accepted the bid if the bound was set much higher. We only have qualitative data[3] to understand if the bid was rejected because it was too low. If we incorrectly captured the landholder's willingness to accept a monetary incentive, then our results are biased (please refer to Section 2.4.1 for further discussion). With the assumption that the second bid was not well designed, we conducted an analysis on the first bid alone and find that the results are robust to model specification.

The remainder of this article is as follows: we introduce payments for environmental services and its relevance in Brazil; we then describe the experimental design conducted in Brazil, followed by descriptive statistics and our empirical strategy; and we then present the results and conclude.

2.2 A Brief Introduction to Payments for Environmental Services Programs and the Brazilian Context

Payments for Environmental Services (PES) seek to correct externalities by using monetary subsidies to incentivise individuals to preserve or restore public goods (such as forests) or common goods (such as water). A variety of market failures impede individuals from allocating socially optimal levels of conservation effort. Social benefits of conservation may disproportionally accrue to certain groups. For instance, land-degrading activities upstream may have large adverse effects on those living downstream, with little direct impact on upstream users. While tree planting is socially optimal, upstream individuals will not internalise the benefits and, therefore, risk not investing in conservation activities. In this setting, a direct subsidy to upstream landholders will reduce the wedge between private and public marginal benefits. This is the idea behind PES programs. Typically, landowners will be offered

[3] Low response rate due to truncation as the question was only asked to those households who rejected the monetary incentive.

a payment conditional on changing or maintaining environmentally desirable land and resource management practices.

Understanding the benefits and pitfalls of this approach is crucial, as the number of PES programs has steadily increased over the last decade, especially in Latin America. In Brazil, several states have launched PES pilots[4], mainly with a focus on preventing deforestation and its side effects, such as erosion. While the monetary incentives are expected to help landowners overcome barriers to invest in inputs needed to transition from their current land use, it is unclear that they would be sufficient to trigger behavioural change in the absence of other incentives, information campaigns, and additional trainings. The present study adds to the current state of evidence on determinants of demand in the context of a government-led PES program in the state of São Paulo (SP), Brazil. Around 40 percent of the state is at risk of erosion, which is a major contributor to the state's worst water crisis to date affecting 20 million people. Against this background, the state policy on climate change was adopted in 2009 to promote large-scale restoration. The program we study (*Mina d' A'gua*) was one of the policy instruments piloted under this initiative.

It is the first PES project implemented directly by the SP state government and was developed in partnership with twenty-one municipalities.

2.3 Analytical Framework

2.3.1 Determinants of Demand

From the landholder's perspective, there are many potential drivers for investment in a PES program. We group these motivations in two categories: extrinsic motivations and intrinsic motivations. According to the rational choice model, the landholder responds only to extrinsic incentives: he will conserve if the monetary benefits exceed the costs. Conservation beyond the expected level of a strict profit-maximizing

[4] See Pagiola (2013) for results from these programs

landholder suggests the individual may hold intrinsic motivations that lead him or her to conserve some portion of land irrespective of costs and benefits.

We consider three *extrinsic* drivers of demand for investment in a conservation or restoration program, which are not mutually exclusive, along with their expected effect on behaviour:

1. *Level of monetary incentive* (the "carrot"): the higher the incentive offered, the more likely a landholder will accept the payment and conserve his property.

2. *Opportunity cost of land:* the higher the opportunity cost embodied in alternative income generating activities, the less likely a landholder will conserve his land.

3. *Prolegal motivation* (the "stick"): the landholder will conserve all land required under the conservation law in order to avoid fines. Under the Brazil Forest Code, a landholder is responsible for the full preservation of "permanent forest preservation areas" (APP), which includes areas adjacent to rivers and ponds, steep hillsides, and springs.[5]

We consider four main *intrinsic* drivers of demand for investment in a PES program:

1. *Proenvironment motivation:* the landholder values the existence and importance of the environment.

2. *Prosocial motivation:* the landholder values protection of the environment for his community members and society as a whole, current, and/or future (Eckel and Grossman, 1996; Meier, 2007).

3. *Progovernment motivation:* the landholder believes the government is responsible for paying to protect water sources on private, and separately, public property.

[5]In the case of springs, the permanent forest preservation areas (APP) consists of a fifty meter radius from the center of the spring.

4. *Social norms:* the landholder incorporates the perceptions of their neighbour with regards to PES into their own decision-making.

As discussed, we are especially interested in the interaction of extrinsic incentives on intrinsic motivations. While the expected effect on conservation behaviour of each driver in isolation is straightforward, the effect of the interaction between extrinsic and intrinsic motivations is a priori ambiguous given the possibility of the monetary incentive supporting or undermining the landholder's intrinsic motivation.

2.4 Data and Experimental Setup

2.4.1 Data Collection

The survey designers ran a randomised experiment within the baseline survey for a pilot PES program in the state of SP. The baseline survey was carried out in 2013 in two municipalities, Ibiúna and Guapiara, both located in the southeast region of SP state. Each municipality established priority areas for conservation and restoration, which typically consist of water basins exploited by local water companies that distribute domestic water to the surrounding communities. In the study area, the survey designers listed all landowners in the catchment of these priority water basins and their adjacent areas. Within that group, they sampled all agricultural landowners with at least one spring on their parcel. In total, they surveyed 350 landowners. The survey captures patterns of land and water use, agricultural production, and income. The survey designers also elicited WTA for PES programs using randomly assigned offer levels and conducted an exhaustive survey of landholders' attitudes toward environmental issues. The *descriptives* in Section 2.5 discuss the characteristics of the surveyed landholders.

2.4.2 Data Generation for Extrinsic and Intrinsic Motivations

We now detail the data generation strategy we employ to measure extrinsic and intrinsic motivations in our survey.

1. Eliciting responses to extrinsic incentives

   To understand how landholders respond to extrinsic motivations, we introduce a monetary incentive: the survey presented landowners with two hypothetical PES projects, one for conservation and one for restoration. A key question in any PES program is the amount that should be paid to the landholder. In principle, the amount should be set based on the value of the services being provided. In practice, this is very difficult to do. Contingent valuation (CV) has increasingly been used in the PES context (Whittington and Pagiola, 2012). If the landholder is motivated only by extrinsic motivations, the expectation is that he would not accept a payment for conservation that is less than his opportunity cost and would not accept a payment for restoration that is less than the sum of his opportunity and restoration costs. Any finding contradicting these assumptions would prompt us to consider alternative motivations for the landholder's behaviour. According to Whittington and Pagiola (2012) the objective of a CV in this context is to determine the minimum compensation that sellers would accept to change their behaviour and/or undertake a new set of land use activities, or both.

   The vast majority of applications of CV in a PES context to date has been estimating the Willingness to Pay (WTP) of water users for the improved water services that PES can provide. Whittington and Pagiola (2012) identified 25 such studies, and more have been undertaken since. In contrast, they found only one CV study that examined service providers' WTA payments to undertake specific activities (Southgate et al., 2010); in addition, there was one application of conjoint analysis (Porras and Hope, 2005). Southgate et al. (2010) estimate landholder WTA for conservation in Guatemala and Ecuador. They find that WTA differs substantially among landholders at their sites. However their sample is a small group of subsistence-oriented farmers in Guatemala and Ecuador. The context is very different from that of southern Brazil, where commercial activities play a much greater role in farming, and where both the implementation and the opportunity costs of conservation are much higher. Ma et al. (2012) examine WTA in the context of farmer willingness to participate in a conservation program. They argue that there are two hurdles to participation: farmers first decide whether to consider enrolling (which depends on farm and farmer characteristics), and then whether to participate (which depends on the payment offered).

The CV in this study was developed in light of best practice guidelines (Bateman et al., 2002; Whittington, 2010; Whittington and Pagiola, 2012) with the assistance of Dale Whittington (University of North Carolina at Chapel Hill), one of the leading experts in the field. The instrument was pre-tested in the field in 2012.

The *conservation project* offered a yearly payment per hectare of conserved APP in compliance with the law. The payments were proportional to the size of the forest cover in APP areas. The first offer ranged from R$150 to R$300 per year per hectare. The upper bound of R$300 per year per hectare is equivalent to the average annual return of keeping livestock on degraded pasture, according to informal discussions with SP state secretariat of environment.

The *restoration project* offered a one-time payment to restore any uncovered degraded APP area. As opposed to the annual conservation payments, this was a one-off, nonrenewable payment to the household. Given the large costs of restoration, payments were higher than in the conservation program. Similar to the conservation offer, payments were proportional to the size of the uncovered APP areas. The first offer ranged from R$2,000 to R$5,000 per hectare and was determined using the costs borne to the government for similar restoration activities (R$4,000 per hectare).

In the survey, the enumerator first described the concept of PES, then the specific MdA project and its requirements. The enumerator asked if the landholder had ever heard of such a program (PES), if the landholder would like to participate in such a program, and if they understood what APPs are. Then two scenarios (conservation and restoration PES programs) were presented sequentially to each landholder. First, the landholder was asked "Would you be interested in participating by receiving $ X per year to conserve one hectare?". If the landholder declined, then they were offered another yet final higher offer (see more details below on the double-bounded CV method). Then the landholder was asked if they were sure of their answer, and the reason for why (or why not) they would be willing to (or not) receive the amount to conserve the forest in the APP areas. See Table 2.1 for bid levels.

The landholder was then presented with a scenario in which the government pays to restore APPs, and asked if they would be interested in participating by receiving a one-time payment of R $ X per hectare and if not, the landholder was offered another yet final higher offer. Again the enumerator asked the landholder if they were sure of their answer, and the reason for why (or why not) they would be willing (or not) to receive the amount to restore the APPs. The full instrument can be found in Appendix A.1.

The researchers who designed the CV method (Whittington and Pagiola) use a double-bounded dichotomous contingent valuation model to elicit individual willingness-to-accept compensation for a PES program. Double bounded elicitation methods are common practice in environmental valuations (see for example Bateman et al. (2002)).

Table 2.1: Offers per Hectare (in R$)

	Conservation		Restoration	
Payment	Bid 1	Bid 2	Bid 1	Bid 2
Level 1	150	225	2,000	3,000
Level 2	200	300	3,000	4,500
Level 3	250	375	4,000	6,000
Level 4	300	450	5,000	7,500

If the landholder accepted the first offer, then no second offer was made. If the first offer was turned down, a second and final offer was made, which was 50 percent greater than the first bid (Table 2.1). It is important to note that the use of this particular double-bounded format by the research team is non-standard. Specifically, respondents were not offered a lower bid if they accepted the first compensation amount offered. See caveats below.

Crucial for our analysis, the incentive offer was randomised across four different levels among the surveyed landholders. The randomization was stratified across the two municipalities and in the priority and adjacent areas. Please refer to the descriptives section for information on balance tests.

As mentioned, the field experiment was carried out within a baseline survey for a pilot PES program in the state of SP. We use data from the survey on land and water use, agricultural production, and income as proxies for opportunity costs in the regression analysis.

To measure legal compliance, we consider landholders to be "prolegal" if they conserve land where it is required by law in order to avoid fines. To verify if the landholder is in full compliance with the law, we documented existing levels of conservation on each hectare of the landholder's property when the survey was administered, including hectares under APP and outside of APP. We devise an indicator taking the value of 1 if the landholder is currently in full compliance with the APP law[6] and 0 if not.

[6] Full compliance requires conserving 100 percent of land under APP and at least 20 percent of land not under APP.

Caveats to the CV instrument

There is a large literature on CV methods and documentation of its development (for example, see Bateman et al. (2002)). According to nine principles for designing a CV study outlined in Whittington and Pagiola (2012), the survey designers followed best practices by asking debriefing questions, such as follow-up questions eliciting the reasons why the respondents agreed to accept or did not agree to accept the offer. The instrument collected data on the constraints that landholders might face in undertaking restoration, even if a payment makes it profitable (such as lack of knowledge on how to do so, lack of access to needed inputs, lack of financing for the necessary investments, etc.). Please refer to Appendix A.1 for the full instrument.

However, the application of CV to this study has limitations and may not have adequately captured the true WTA value. In particular, the bid levels used were too narrow and thus may not have spanned the true range of respondents' preferences. Additionally, we do not know if the respondents who replied 'yes' to the first bid would have accepted a lower amount.

One of the inefficiencies with the CV method in general is the sample size requirements (Foster and Mourato, 2003). While 350 respondents is a sufficient sample size to elicit the WTA value, we are unable to analyze the follow-up responses due to power issues to understand why landholders chose not to accept the offer in order to rule out issues with the instrument.

As the responses to the second bid is conditional on the first bid response, we do not measure purely independent responses to calculate the average WTA. The largest concern with using the data from this CV method is that it captures the monetary incentive used in the behavioural analysis. If the method has shortcomings, then the data may be inaccurate and thus the results in this paper must be taken with great caution. To test if the conditionality had an impact on the results, we include a robustness check by conducting an analysis on the first bid alone. We find the results are robust to model specification (see Table 2.8 and Table 2.9 in the Results section).

Another natural concern is that the valuations were hypothetical. The survey designers put great effort into developing an introduction on PES and a list of comprehensive questions after the CV to encourage the respondent to critically consider the reasons for or against accepting the incentive. As another robustness check, Appendix B tests the effect of motivations on program take-up. The correlations between motivations and take-up are robust to the correlations between motivations and accepting the hypothetical incentives in this paper. In other words, the same type of landholders who accepted (or not) the hypothetical offer then later indeed enrolled (or not) in the PES program.

2. Eliciting intrinsic motivations: survey responses

To elicit intrinsic motivations, we use data from the detailed survey questions on perceptions of conservation and society. The survey responses allow us to identify landholders as motivated by proenvironment, prosocial, progovernment, or social norms attitudes as described in the analytical framework. Using factor analysis, we construct indices to reduce the dimensionality of the proxies for motivations in an earlier working paper (see Appendix A.1 for the list of indices and Appendix B for the full paper on construction of the indices). We then test if stated preferences as captured in the indices determine revealed preferences, as measured by existing levels of conservation at the time of the survey. This step is crucial to establish that the indices provide a valid measure of latent intrinsic motivations.

Our results, reported in an earlier working paper (Appendix B), show that stated preferences are in fact consistent with revealed preferences once we control for opportunity costs, and we refer readers to this working paper for further discussion.

2.5 Descriptive Statistics

2.5.1 Extrinsic Drivers: Monetary Incentives

The percentage of households who accepted the first and second bid, respectively, is reported in Table 2.2. Independent of the treatment level, half of the sample accepted the first bid for the conservation program, and one-third of the sample accepted the first bid for the restoration program. We observe monotonic responses from those who rejected the first offer but then accepted the second, higher, offer. 20 to 30 percent accepted the second and final bid for the conservation program whereas only 11 to 17 percent of this sample accepted the second and final bid for the restoration program (Table 2.2).

Balance tests on the four randomised treatments were carried out on observable characteristics. Small yet significant differences across treatments arise from the age of the head of household, credit use, area of property, amount of erosion on property and conservation within APP zones (Table 2.3)[7], and are controlled for in all estimation models. Take-up of the conservation bid was 60 percent of the sample, whereas take-up of the restoration bid was 43 percent of the sample.

Table 2.2: Bids Accepted

	Percentage accepted first bid (%)	Percentage accepted second bid of those who rejected first bid (%)
Conservation offer (in R$)		
150; 225	50	21
200; 300	45	31
250; 375	45	26
300; 450	48	18
Restoration offer (in R$)		
2,000; 3,000	37	11
3,000; 4,500	33	13
4,000; 6,000	33	12
5,000; 7,500	36	17

[7]Full balance tests are available in Appendix B.

Table 2.3: Property Characteristics

Property characteristics	Total	Guapiara	Ibiúna	Difference
Size of the property (Ha)	12.2	12.2	12.3	
Household lives on the property (%)	81	91	72	***
Has no area designated to agriculture (%)	20	7	30	***
Agriculture is used for own consumption (%)	75	81	69	**
Agriculture is only used for own consumption (%)	32	29	34	
Area of property covered with forest (%)	43	31	53	
Has erosion on part of the property (%)	11	17	6	***
Has livestock (%)	61	74	50	***
Number of springs	1.9	1.7	2.1	**
Observations	350	188	162	

Note: "Difference" denotes t-tests of means (Guapiara vs. Ibiuna).
**p <.05. ***p <.01.

2.5.2 Extrinsic Drivers: Opportunity Costs and Legal Compliance

Our average landholder holds a little over twelve hectares of land - a small-scale producer by Brazilian standards (Table 2.2). About 15 percent of the sample uses credit. For those who do not use credit, 76 percent of the sample stated it was because they did not need credit. Thus, we are analyzing a sample that is not credit constrained or not undertaking investments. Thirty percent of the sample experienced a bad agricultural yield in the previous year. We find that Guapiara experiences higher levels of erosion than Ibiuna. Although over 80 percent of our sample uses at least part of their land for agriculture (Ibiuna 70 percent and Guapiara 93 percent), properties in our sample have high forest cover (Ibiuna 53 percent and Guapiara 31 percent). At the time of the survey, 52 percent of landholders were in full compliance with the APP law (Ibiuna 56 percent and Guapiara 48 percent). Ibiuna landholders mostly engage in horticulture, while Guapiara producers mainly produce annual crops and use significantly more livestock. In our estimation, we account for these differences using municipality fixed effects.

2.5.3 Intrinsic Drivers: Motivations

Table 2.4 presents the breakdown of the sample by intrinsic drivers: proenvironment, prosocial, progovernment, and social norms. The average respondent answered positive to 52 percent of the proenvironment questions, whereas the average respondent answered positive to only 8 percent of the prosocial questions. When looking at the descriptives of those who accepted the restoration bid, the average respondent answered positive to 56 percent of the proenvironment questions and to only 4 percent of the prosocial questions.

The average landholder responded positively to 61 percent of the progovernment questions and 87 percent of the questions on social norms influence. On average, the landholder responded positively to 52 percent of the questions on knowledge of PES and the MdA program in particular. Those who accepted the restoration bid responded positively to 71 percent of the progovernment questions, 95 percent of the questions on social norms influence, and 54 percent of the questions on access to information.

Table 2.4: Indices

Intrinsic motivation index	Number of questions in additive index (standardized in regressions)	Mean number of "Yes" replies (n=351)	Standard deviation	Mean number of "Yes" replies for those who accepted conservation bid (n=210)	Mean number of "Yes" replies for those who accepted restoration bid (n=151)
Proenvironment	7	4.72	2.35	4.79	5.07
Prosocial	1	0.08	0.27	0.06	0.04
Progovernment	3	1.84	1.22	1.98	2.12
Social norms	2	0.87	0.38	0.95	0.96
Access to information	3	1.04	.80	1.06	1.07

The descriptives are consistent with the regression results later: landholders with prosocial motivations are unequivocally less likely to accept the monetary incentive, while proenvironment landholders are less likely to accept the monetary incentive only at high offer levels. Landholders with progovernment motivations, social norms influence, and access to information, on the other hand, are categorically more likely to accept the monetary incentive.

2.6 Experimental Results

This section presents our regression results. First, we determine the average WTA value of the extrinsic (monetary) incentive. Second, in order to gain a richer understanding of the effect of opportunity costs, intrinsic motivations, and the interaction of intrinsic motivations and the extrinsic randomised incentive offer, we use a probit model to determine the main drivers of demand for investment in PES.

2.6.1 Maximum Likelihood Estimation (MLE) of WTA Model

The average WTA value is analyzed using a double-bounded dichotomous model. We construct a likelihood function and use MLE to obtain the coefficients. We estimate the average monetary amount required to comply with the requirements of the conservation and, separately, the restoration program as observed in the sample independent of the randomised offer level. We represent the first bid amount by t^1 and the second bid by t^2. Thus, the landholder will belong to one of the following three categories:

1. The landholder answers yes to the 1st bid: the probability is $\Pr(\mathrm{WTA} \leq \mathrm{t})$.

2. The landholder answers no to the 1st but yes to the 2nd bid: the probability is $\Pr(\mathrm{t}^1 < \mathrm{WTA} \leq \mathrm{t}^2)$.

3. The landholder answers no to the 1st bid and the 2nd bid: the probability is $\Pr(\mathrm{t}^2 < \mathrm{WTA} < \infty)$.

Employing a WTA model, we calculate the average using a double-bounded model (Lopez-Feldman, 2012) with dichotomous choices under the assumption that there is a single valuation function behind both answers. y_i^1 and y_i^2 are the dichotomous variables that capture the response to the first and second questions. To obtain estimates for the average WTA (represented as b and s), we construct a likelihood function and use MLE programming to obtain the coefficients[8]:

$$\sum_{i=1}^{N} = d_i^{nn} ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right) + d_i^s ln\left(1 - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right)\right) + d_i^{ns} ln\left(\Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^1}{\sigma}\right) - \Phi\left(z_i'\frac{\beta}{\sigma} - \frac{t^2}{\sigma}\right)\right)$$

where d_i^{nn}, d_i^s, d_i^{ns} are variables that take the value of one or zero depending on the response to y_i^1 and y_i^2. First we estimate the WTA without covariates and then we control for opportunity costs as defined by the $Demographics_i$ and $Landcharacteristics_i$ vectors (see Table 2.5).

Result 1: Average WTA value is low for the conservation program but high for the restoration program.

Table 2.5: Willingness to Accept (WTA) Estimates

Program	Direct WTA	WTA with covariates
Conservation	R$244	R$233
Restoration	R$7,030	R$6,853

The average WTA for the conservation program lies between the first and second offer level, whereas the average WTA for the restoration program is much higher and lies between the third and fourth (highest) offer level. The higher average WTA for the restoration program is indicative of the program's requirement to reallocate time, labor, and money to reforest the property and affect potential farming land. By contrast, the conservation program requires less effort.

The complementary model below further explores the characteristics of households who accepted an incentive for the conservation, and separately, the restoration program to understand the determinants of a relatively low WTA, and highlights

[8] "Doubleb" is an existing STATA 13 command created by Alejandro Lopez Feldmen from Centro de Investigación y Docencia Económicas. However, it will only calculate willingness to pay and does not allow for discontinuities from a WTA model. Thus, we expanded the Doubleb command to include a maximum likelihood function for WTA models. Without controls, the function can be estimated by .doubleb2 bid1 bid2 answer1 answer2. The doubleb2 command directly estimates b.

results that corroborate the main finding that there exists large heterogeneity in response to incentive payments.

2.6.2 Interacting Intrinsic Motivations and Extrinsic Incentives

We estimate landholder-level probit regressions where the dependent variable $Accept_i$ is a dichotomous variable equal to 1 if landholder i accepted the theoretical incentive to participate in the conservation program and, separately, the restoration program, and zero otherwise. We assume that the probability of acceptance is a function of opportunity costs, indices of intrinsic motivations, the incentive offer, and the interaction of indices and incentives, or:

$$\begin{aligned} Accept_i \;=\; & \alpha + \beta_1\, Demographics_i' + \beta_2\, Land\ characteristics_i' \\ & + \beta_3\, Prolegal_i + \beta_4\, Proenv_i + \beta_5\, Prosocial_i \\ & + \beta_6\, Progovt_i + \beta_7\, Socialnorms_i \\ & + \beta_8\, Access\ info_i + \beta_9\, i.incentive_i \\ & + \beta_{10}\, i.incentivelevel_i \times indices_i + \epsilon \end{aligned} \tag{2.1}$$

$Demographics_i$ is a vector of covariates including household size, education, age, gender of the household head, income, and credit access and use. $Landcharacteristics_i$ is a vector of covariates conventionally used in analyses of PES demand (Sierra and Russman, 2006; Rios and Pagiola, 2010; Pagiola et al., 2010; Arriagada et al., 2009; Pfaff et al., 2008; Robalino et al., 2008) and are comprised of property size in hectares, number of people working on the land, possession of legal documents for ownership or renting of the property, soil characteristics (sand, clay, mix, and red soil), steepness of land, evidence of erosion on property, number of springs on property, if the landholder experienced a bad yield in the previous year, (log) profits from agriculture, and a binary variable indicating whether the property is used for agriculture. Although it is an empirical question, if the landholder has more land,

and more workers on the land, we may expect them to be more willing diversify land use and to enroll part of their property in a PES program compared to a smaller landholder who may not have the ability to diversify their land use. As this depends on the motivations of the landholder, we will observe the effects of including motivations as independent variables (see below). Those with property rights that are well defined may be more likely to invest and take care of their land. Especially if the land is suffering from high erosion, the landholder may be more willing to participate in a restoration program. Furthermore, flatter land is expected to be more productive and thus conserving it would entail higher opportunity costs.

$Prolegal_i$ is a dichotomous variable equal to 1 if the landholder is in full compliance of the APP law at the time of the survey and 0 otherwise.

To go beyond the strict homo economicus landholder, we are interested in empirically documenting the role of intrinsic motivations in determining demand for PES. As outlined earlier, we consider four main intrinsic drivers of investment in the program: $Proenvironment_i$, $Prosocial_i$, $Progovt_i$, and $Socialnorms_i$.

We also consider $AccesstoInformation_i$ an important and final covariate to determine if those who have access to and understand information on PES and the MdA program of interest have higher demand for PES programs.

i.incentive is a vector of dummy variables for the four randomised levels of payments, using the lowest offer as the base. The variable i.incentive $\times$ i.indices captures the effect of interacting the randomised monetary incentive with the various motivations. The motivations of interest in the heterogeneity analysis are prolegal, proenvironment, prosocial, progovernment, social norms, and access to information.

Finally, ϵ_i is an independently distributed error term assumed to be normally distributed with zero mean and a constant variance.

Marginal effects are computed for continuous and dichotomous explanatory variables. Standard errors are clustered at the municipality level.[9] Estimation results are reported in Table 2.6. As we are measuring elasticities of demand, the interpret-

[9] We tested equality constraints of all parameters and rejected the hypothesis that the parameters are equal.

ation of coefficients is in percentage change, except when analyzing the standardised indices, which are interpreted as increases in standard deviations above the mean.

Result 2: Demand for conservation and restoration is nonmonotonic with respect to extrinsic monetary incentives.

If landholders are profit-maximizing agents, the prediction is that a higher subsidy offer will yield higher demand for the PES program. Our first result contradicts this monotonicity assumption (Tables 2.6 and 2.7). We pool the four randomised treatment offer levels into two groups, high offer and low offer. Landholders are 5 percent less likely to accept the conservation offer if assigned to the high payment treatment compared to those who received the low payment treatment. This is consistent across all specifications. For the restoration program, the likelihood to accept a payment also decreases with a high monetary offer, and the magnitude is even greater: landholders are 26 percent less likely to accept the payment if assigned to the high offer versus the low offer.

Result 3: Landholders with high opportunity costs are less likely to accept the extrinsic incentive.

In our third specification, we regress demographics and land characteristics on accepting a conservation payment, controlling for the high offer level, which is highly significant and negative.[10] The results consistently show that various measures of high opportunity cost are associated with lower demand for the programs. As an example, landholders who use most of their land for agriculture are 14 percent less likely to accept the incentive for the conservation program and 10 percent less likely to accept the incentive for the restoration program (Tables 2.6 and 2.7). As the number of members that participate in agricultural activity increases by one worker, the landholder is 3.8 percent less likely to accept the conservation incentive. However, having experienced a bad agricultural yield in the previous year is associated with

[10] The high offer treatment is highly significant and negative for the restoration payment in the fully specified model.

a 10 percent greater likelihood to accept the incentive for the restoration program. If the property suffers from any erosion problems,[11] the landholder is 5 percent less likely to accept the offer for restoration. Restoration of these properties may be too expensive for the landholder and the payments may not fully compensate the costs. In general, the income elasticity of demand was significant and negative for restoration program. As income from agriculture increases,[12] the landholder is 20 percent less likely to accept the payment for the restoration program.

Result 4: Policies may be redundant.

In our context, a purely profit-maximizing landholder would include the expected legal cost of noncompliance with the APP zoning laws in the utility-maximization function. We find that being prolegal is associated with an 8 percent increase in landholders' probability of accepting the conservation offer. When interacted with the randomised offer levels, prolegal landholders are 12 percent more likely to accept the offer if in the high offer treatment relative to the low offer treatment. When analyzing the results from the restoration program, we find that prolegal landholders are 5 percent more likely to accept the offer. In the fully interacted model, the prolegal landholders are 20 percent more likely to accept the offer if they are assigned to the high offer treatment relative to the low offer treatment. According to Frey's model, prolegal landholders may perceive the incentive, and especially higher levels of the incentive, as supporting their self-evaluation of legal compliance. An alternative explanation is that the program's administration costs are perceived to be too high to make it worth it for these landholders to accept the subsidy at low levels of subsidy. It may not be immediately clear that increasing the level of the subsidy to elicit prolegal landholders to take up the program makes any fiscal sense if these

[11] This is a dichotomous variable equal to 1 if the landholder answered yes to the question "is there any erosion on your property?"

[12] Farm costs were determined from self-reported survey data on fertiliser and seeds; fuel; packing material; animal feeding; storage; rent for machines, pasture, and land; and temporary labor, fixed labor, electricity, utilities, taxes, repayments of credit, maintenance of machines, transportation, technical assistance, and other activities and inputs. Farm revenue similarly was determined from cultivation of annual crops, perennials, and vegetables; cultivation of pinus, eucalyptus, and sugarcane; and from animals and animal products as reported by the household in the survey.

Table 2.6: Estimation results

Accept conservation program incentive	I Means	II Offer level	III Opp costs	IV Offer level & Opp costs	V Opp costs & indices	VI Offer level, opp costs & indices	VII Fully interacted model
High offer treatment (level 3 and 4)	0.49			-0.048***		-0.053**	-0.061
	0.027			0.018		0.027	0.042
Second payment offer level		0.006					
		0.095					
Third payment offer level		-0.02					
		0.015					
Fourth payment offer level		-0.04					
		0.153					
No. of HH members	3.915		0.008	0.008	0.005	0.006	0
	0.145		0.013	0.012	0.007	0.006	0.004
Gender HH head	0.853		-0.163	-0.162	-0.111	-0.107	-0.12
	0.019		0.146	0.143	0.175	0.169	0.168
Age of HH head	55.425		-0.002	-0.002	-0.001	-0.001	-0.001
	0.753		0.003	0.003	0.003	0.003	0.002
Education of HH head[13]	2.469		0.019	0.019	0.026***	0.025***	0.025***
	0.063		0.016	0.016	0.004	0.005	0.008
Income from agriculture-units of minimum wage[14]	1.326		0.008	0.008	0.002	0.002	0.001
	0.087		0.015	0.016	0.009	0.01	0.01
HH uses credit (y/n)	0.147		-0.022	-0.015	-0.045	-0.037	-0.047
	0.019		0.092	0.088	0.091	0.088	0.102
ln(profit)	12.126		-0.097	-0.108	-0.055	-0.067	-0.045
	0.008		0.12	0.112	0.073	0.063	0.049
Ibiuna	0.54	0.080***	0.057	0.058	0.057	0.057	0.057
	0.027	0	0.055	0.055	0.055	0.055	0.049
Experienced bad agricultural yield in previous year	0.29		0.111	0.111	0.084	0.083	0.091
	0.025		0.162	0.165	0.157	0.161	0.135
Total area of property (Ha)	12.506		0.003*	0.003*	0.003**	0.003**	0.003**
	0.713		0.002	0.002	0.001	0.001	0.001
Number of members that participate in agriculture activity	1.962		-0.038***	-0.039**	-0.028*	-0.029*	-0.023
	0.117		0.014	0.016	0.016	0.017	0.022
Has legal documents for property (y/n)	0.883		0.050***	0.052***	0.039	0.043	0.044
	0.017		0.011	0.008	0.042	0.037	0.027

[13] Average of five response options: never attended (1), elementary-incomplete (2), elementary - complete (3), high school(4), higher education (5)

[14] The minimum wage is used to define the national poverty line and in the agricultural context farmers do not have a monthly wage which is either above or below the minimum wage but instead they express the average farming income in relation to units of minimum wage.

Sand	0.267		0.059	0.06	0.093	0.094	0.092
	0.024		0.131	0.138	0.101	0.109	0.103
Clay	0.258		0.007	0.009	0.054***	0.059***	0.042***
	0.024		0.016	0.02	0.014	0.009	0.007
Sand-clay	0.226		0.014	0.011	0.031	0.03	0.014
	0.023		0.041	0.039	0.024	0.021	0.028
Terra Roxa	0.437		0.054***	0.058***	0.107***	0.112***	0.106***
	0.027		0.006	0.003	0.02	0.016	0.015
Proportion of total steepness over total property	0.754		-0.024	-0.019	-0.027	-0.02	-0.033
	0.015		0.061	0.054	0.11	0.099	0.08
# of properties eroded	0.15		0.013	0.007	0.056***	0.050***	0.052***
	0.027		0.015	0.014	0.005	0.004	0.002
Land used for agriculture (ha)	0.804		-0.146***	-0.144***	-0.131***	-0.128***	-0.122***
	0.022		0.047	0.048	0.049	0.049	0.043
Chance of deforesting around APP spring (y/n)	0.044		0.111***	0.102***	0.172*	0.168*	0.145
	0.011		0.028	0.024	0.104	0.098	0.102
% of non-APP land conserved	0.381		-0.127***	-0.131***	-0.100***	-0.106***	-0.122**
	0.018		0.013	0.014	0.026	0.024	0.051
Prolegal	0.525		0.078**	0.078**	0.110***	0.108***	0.104***
	0.027		0.033	0.032	0.034	0.032	0.021
Access to information on PES (std)	0.009				0.018	0.016	0.050***
	0.054				0.042	0.04	0.016
Social norms (std)	-0.01				0.122***	0.123***	0.088***
	0.054				0.011	0.008	0.019
Proenvironment (std)	0.003				-0.016***	-0.014***	0.001
	0.054				0.004	0.004	0.052
Prosocial (std)	0.008				-0.016***	-0.019**	-0.013
	0.055				0.006	0.009	0.01
Progovernment (std)	-0.009				0.071***	0.069***	0.030***
	0.054				0.015	0.014	0.005
Interaction high offer and proenvironment (std)							-0.04
							0.108
Interaction high offer and prosocial (std)							-0.039
							0.062
Interaction high offer and progovernment (std)							0.073***
							0.01
Interaction high offer and prolegal							0.019***
							0.006
Interaction high offer and access to information (std)							-0.068
							0.052
Interaction high offer and Social Norms influence (std)							0.088
							0.083
Observations	348	351	348	348	348	348	348

Note: APP $\frac{1}{4}$ permanent forest preservation areas; HH $\frac{1}{4}$ household.
*p <.10. **p <.05. ***p <.01.

Table 2.7: Estimation results

Accept restoration program incentive	I Means	II Offer level	III Opp costs	IV Offer level & Opp costs	V Opp costs & indices	VI Offer level, opp costs & indices	VII Fully interacted model
	I	II	III	IV	V	VI	VII
High offer treatment (level 3 and 4)	0.49			-0.02		-0.017	-0.256***
	0.027			0.018		0.017	0.007
Second payment offer level		-0.031					
		0.085					
Third payment offer level		-0.041**					
		0.019					
Fourth payment offer level		0.017					
No. of HH members	3.915		0.003	0.004	-0.001	-0.001	-0.005
	0.145		0.009	0.01	0.014	0.014	0.012
Gender HH head	0.853		-0.171*	-0.170*	-0.118	-0.117	-0.116
	0.019		0.09	0.09	0.117	0.117	0.098
Age of HH head	55.425		0.001	0.001	0.001	0.001	0.001
	0.753		0.003	0.003	0.002	0.002	0.003
Education of HH head[15]		0.042***	0.042***	0.042***	0.042***	0.038***	
	0.063		0.015	0.015	0.003	0.003	0.004
Income from agriculture-units of minimum wage[16]	1.326		-0.002	-0.002	-0.009***	-0.010***	-0.012***
	0.087		0.001	0.002	0.001	0	0
HH uses credit (y/n)	0.147		-0.004	-0.001	0.003	0.005	-0.006
	0.019		0.125	0.119	0.114	0.109	0.123
ln(profit)	12.126		-0.199*	-0.204*	-0.184***	-0.188***	-0.187**
	0.008		0.107	0.11	0.07	0.072	0.083
Ibiuna	0.54	0.211***	0.103***	0.103***	0.110***	0.110***	0.122***
	0.027	0.003	0.021	0.021	0.012	0.013	0.001
Experienced bad agricultural yield in previous year	0.29		0.119	0.119	0.094**	0.094**	0.100***
	0.025		0.078	0.079	0.044	0.046	0.03
Total area of property (Ha)	12.506		0.002***	0.002***	0.002**	0.002**	0.002*
	0.713		0.001	0.001	0.001	0.001	0.001
Number of members that participate in agriculture activity	1.962		-0.035	-0.036	-0.018	-0.019	-0.014
	0.117		0.026	0.027	0.027	0.027	0.023
Has legal documents for property (y/n)	0.883		-0.112***	-0.111***	-0.116***	-0.115***	-0.121***
	0.017		0.003	0.003	0.028	0.028	0.022

[15] Average of five response options: never attended (1), elementary-incomplete (2), elementary - complete (3), high school(4), higher education (5)

[16] The minimum wage is used to define the national poverty line and in the agricultural context farmers do not have a monthly wage which is either above or below the minimum wage but instead they express the average farming income in relation to units of minimum wage.

Sand	0.267		0.094	0.095	0.120***	0.121***	0.110***
	0.024		0.074	0.076	0.017	0.02	0.002
Clay	0.258		0.085	0.087	0.115***	0.116***	0.099***
	0.024		0.055	0.056	0.025	0.025	0.004
Sand-clay	0.226		0.015	0.014	0.027	0.027	0.022
	0.023		0.012	0.012	0.025	0.025	0.042
Terra Roxa	0.437		-0.063	-0.061	-0.019	-0.017	-0.001
	0.027		0.064	0.064	0.037	0.036	0.015
Proportion of total steepness over total property	0.754		0.029	0.03	0.041	0.043	0.033
	0.015		0.061	0.06	0.11	0.11	0.085
# of properties eroded	0.15		-0.046***	-0.048***	-0.020***	-0.022***	-0.016**
	0.027		0.002	0.005	0.002	0.005	0.006
Land used for agriculture (ha)	0.804		-0.095***	-0.095***	-0.089***	-0.089***	-0.100***
	0.022		0.012	0.011	0.008	0.007	0.011
Chance of deforesting around APP spring(y/n)	0.044		-0.133	-0.136	-0.11	-0.111	-0.132
	0.011		0.141	0.146	0.112	0.114	0.118
% of non-APP land conserved	0.381		-0.119***	-0.122***	-0.077**	-0.079**	-0.079***
	0.018		0.027	0.029	0.038	0.04	0.026
Prolegal	0.525		0.049***	0.049***	0.064***	0.063***	-0.069*
	0.027		0.015	0.015	0.004	0.003	0.04
Access to information on PES (std)	0.009				0.032**	0.031*	0.052***
	0.054				0.015	0.016	0.004
Social norms (std)	-0.01				0.101***	0.102***	0.093*
	0.054				0.029	0.029	0.049
Proenvironment (std)	0.003				0.024	0.024	0.040*
	0.054				0.023	0.024	0.022
Prosocial (std)	0.008				-0.029	-0.03	0.006
	0.055				0.032	0.033	0.047
Progovernment (std)	-0.009				0.083***	0.082***	0.092***
	0.054				0.014	0.015	0.025
		0.165					
Interaction high offer and proenvironment (std)							-0.030***
							0.005
Interaction high offer and prosocial (std)							-0.424***
							0.019
Interaction high offer and progovernment (std)							-0.024
							0.1
Interaction high offer and prolegal							0.264***
							0.053
Interaction high offer and access to information (std)							-0.037
							0.041
Interaction high offer and social norms influence (std)							0.038
							0.069

Observations	348	351	348	348	348	348	348

Note: APP $\frac{1}{4}$ permanent forest preservation areas; HH $\frac{1}{4}$ household; PES $\frac{1}{4}$ payments for environmental services.
*p <.10. **p <.05. ***p <.01.

Table 2.8: Estimation results: Robustness check

Accept 1st Conservation Bid	(I) Means	(II) Offer level (disaggregated)	(III) Offer level (binary)	(IV) Demographics and Offer Level (disaggregated)	(V) Demographics and Offer level (binary)	(VI) Demographics, Offer level (disaggregated) and motivations
High offer treatment (level 3 and 4)	0.49		-0.01		-0.031**	
	0.027		0.067		0.014	
Value offer	224.34					
	2.992					
Second payment offer level		-0.059		-0.048		-0.031
		0.139		0.088		0.064
Third payment offer level		-0.052		-0.067***		-0.045**
		0.056		0.003		0.02
Fourth payment offer level		-0.029		-0.044		-0.05
		0.22		0.128		0.101
No. of HH members	3.915			0.026	0.026	0.023
	0.145			0.031	0.035	0.026
Gender HH head	0.853			-0.173	-0.177	-0.141
	0.019			0.164	0.166	0.178
Age of HH head	55.425			-0.003	-0.004*	-0.003
	0.753			0.002	0.002	0.002
Education of HH head[17]	2.469			0.005	0.005	0.01
	0.063			0.027	0.029	0.021
Income from agriculture-units of minimum wage[18]	1.326			-0.013	-0.012	-0.013
	0.087			0.037	0.035	0.031
HH uses credit (y/n)	0.147			0.075**	0.068***	0.063**
	0.019			0.035	0.022	0.028
ln(profit)	12.126			-0.19	-0.186	-0.155
	0.008			0.144	0.148	0.099
Ibiuna	0.54			0.134**	0.133*	0.128*
	0.027			0.064	0.069	0.066
Experienced bad agricultural yield in previous year	0.29			0.138*	0.138*	0.123
	0.025			0.083	0.076	0.087
Total area of property (Ha)	12.506			0.002**	0.002*	0.002**
	0.713			0.001	0.001	0.001

[17] Average of five response options: never attended (1), elementary-incomplete (2), elementary - complete (3), high school(4), higher education (5)

[18] The minimum wage is used to define the national poverty line and in the agricultural context farmers do not have a monthly wage which is either above or below the minimum wage but instead they express the average farming income in relation to units of minimum wage

Number of members that participate in agriculture activity	1.962			-0.070***	-0.070***	-0.061***
	0.117			0.015	0.015	0.012
Has legal documents for property (y/n)	0.883			-0.066***	-0.061***	-0.062*
	0.017			0.016	0.014	0.033
Sand	0.267			0.151	0.151	0.177*
	0.024			0.129	0.141	0.095
Clay	0.258			0.045	0.05	0.077
	0.024			0.036	0.045	0.069
Sand-clay	0.226			0.053	0.054	0.067
	0.023			0.072	0.073	0.092
Terra Roxa	0.437			0.144***	0.145***	0.183***
	0.027			0.052	0.047	0.069
Proportion of total steepness over total property	0.754			-0.007	-0.005	-0.02
	0.015			0.025	0.017	0.054
# of properties eroded	0.15			0.068*	0.072	0.090**
	0.027			0.04	0.047	0.042
Land used for agriculture (ha)	0.804			-0.101***	-0.100***	-0.096***
	0.022			0.001	0.018	0.01
Chance of deforesting around APP spring (y/n)	0.044			0.124	0.118	0.151
	0.011			0.109	0.084	0.112
% of non-APP land conserved	0.381			-0.04	-0.041	-0.023
	0.018			0.141	0.121	0.101
Prolegal	0.525					0.086
	0.027					0.056
Access to information on PES (std)	0.009					0.015
	0.054					0.012
Social norms (std)	-0.01					0.063***
	0.054					0.004
Proenvironment (std)	0.003					-0.008
	0.054					0.018
Prosocial (std)	0.008					-0.025***
	0.055					0.006
Progovernment (std)	-0.009					0.068***
	0.054					0.003
Observations	341	351	351	341	341	341

Note: APP $\frac{1}{4}$ permanent forest preservation areas; HH $\frac{1}{4}$ household; PES $\frac{1}{4}$ payments for environmental services.
*p <.10. **p <.05. ***p <.01.

Table 2.9: Estimation results: Robustness check

Accept 1st Restoration Bid	(I) Means	(II) Offer level (disaggregated)	(III) Offer level (binary)	(IV) Demographics and Offer Level (disaggregated)	(V) Demographics and Offer level (binary)	(VI) Demographics, Offer level (binary), and motivations
High offer (level 3 and 4)	0.49		-0.007		-0.041*	-0.035**
	0.027		0.053		0.021	0.015
Value offer	224.34					
	2.992					
Second payment offer level		-0.038		-0.03		
		0.109		0.109		
Third payment offer level		-0.042		-0.071***		
		0.034		0.016		
Fourth payment offer level		-0.01		-0.04		
		0.183		0.137		
No. of HH members	3.915			0.025***	0.025***	0.021***
	0.145			0.004	0.008	0.003
Gender HH head	0.853			-0.193*	-0.196*	-0.157
	0.019			0.1	0.101	0.12
Age of HH head	55.425			0	0	0.001
	0.753			0.002	0.002	0.002
Education of HH head[19]	2.469			0.029**	0.028**	0.029***
	0.063			0.011	0.013	0.003
Income from agriculture-units of minimum wage[20]	1.326			-0.017	-0.016	-0.018
	0.087			0.02	0.018	0.015
HH uses credit (y/n)	0.147			0.019	0.015	0.011
	0.019			0.067	0.048	0.057
ln(profit)	12.126			-0.202	-0.202	-0.174
	0.008			0.187	0.181	0.132
Ibiuna	0.54			0.148***	0.149***	0.154***
	0.027			0.018	0.026	0.018
Experienced bad agricultural yield in previous year	0.29			0.091***	0.091***	0.078***
	0.025			0.009	0.003	0.005
Total area of property (ha)	12.506			0	0	-0.001
	0.713			0.001	0.001	0.001

[19] Average of five response options: never attended (1), elementary-incomplete (2), elementary - complete (3), high school(4), higher education (5)

[20] The minimum wage is used to define the national poverty line and in the agricultural context farmers do not have a monthly wage which is either above or below the minimum wage but instead they express the average farming income in relation to units of minimum wage

Number of members that participate in agriculture activity	1.962			-0.063***	-0.063***	-0.047***
	0.117			0.003	0.002	0.002
Has legal documents for property (y/n)	0.883			-0.112***	-0.107***	-0.099***
	0.017			0.032	0.034	0.007
Sand	0.267			0.146**	0.147**	0.170***
	0.024			0.061	0.074	0.012
Clay	0.258			0.064***	0.067***	0.092***
	0.024			0.02	0.01	0.033
Sand-clay	0.226			0.100***	0.101***	0.113**
	0.023			0.008	0.01	0.051
Terra Roxa	0.437			-0.003	-0.002	0.038***
	0.027			0.035	0.043	0.008
Proportion of total steepness over total property	0.754			0.058	0.062**	0.05
	0.015			0.036	0.026	0.061
# of properties eroded	0.15			0.007	0.009***	0.026***
	0.027			0.011	0.002	0.006
Land used for agriculture (ha)	0.804			-0.04	-0.038**	-0.035***
	0.022			0.031	0.016	0.011
Chance of deforesting around APP spring (y/n)	0.044			-0.021	-0.022	-0.008
	0.011			0.118	0.138	0.112
% of non-APP land conserved	0.381			-0.091*	-0.090***	-0.052***
	0.018			0.05	0.032	0.018
Prolegal	0.525					0.076***
	0.027					0.028
Access to information on PES (std)	0.009					0.027***
	0.054					0.003
Social norms (std)	-0.01					0.066*
	0.054					0.036
Proenvironment (std)	0.003					0.013***
	0.054					0.001
Prosocial (std)	0.008					-0.032
	0.055					0.053
Progovernment (std)	-0.009					0.073***
	0.054					0.003
Observations	341	351	351	341	341	341

Note: APP $\frac{1}{4}$ permanent forest preservation areas; HH $\frac{1}{4}$ household; PES $\frac{1}{4}$ payments for environmental services.
*p <.10. **p <.05. ***p <.01.

landholders are already incentivised by the law; nevertheless, excluding participants on the basis of their ex ante compliance may be even more problematic if exclusion changes their behaviour ex post of the intervention. However, this question is outside the scope of this analysis.

2.6.3 Results from Analysis of Intrinsic Motivations

We now explore the possibility that the demand response to the randomised offer levels may vary across levels of intrinsic motivations.

Result 5: For proenvironment and prosocial motivated landholders, demand for conservation and restoration programs is undermined by higher monetary incentive levels.

We find evidence that higher monetary incentives crowd-out demand for proenvironment and prosocial landholders. In the fully interacted model for the restoration program, a one-unit increase in standard deviation above the mean in the proenvironment index leads to a 4 percent greater likelihood of accepting the incentive; however, this effect is dampened by 3 percent if the landholder is assigned to the high offer treatment. Thus, interaction with the higher offer treatment crowds-out demand for the restoration program. Following Frey's (1992) model, the high incentive may be undermining the self-determination of proenvironment landholders, as it disengages their interest in the program.

This finding is consistent with evidence from landholders' existing levels of conservation prior to the experiment. Using the percentage of non-APP land conserved as another proxy for proenvironment behaviour, we also find a negative and highly significant association, when controlling for opportunity costs, between the percentage of non-APP land conserved and the likelihood that the landholder accepts the payment for either program. We find similar but even stronger dynamics in the case of prosocial landholders. A one-unit increase in standard deviation above the mean in the prosocial index leads to a 42 percent lower probability of accepting the higher offer for the restoration program (significant at the 1 percent level). The higher offers are significantly disengaging prosocial motivated landholders. In an earlier analysis, we found a positive association between the prosocial index and existing levels of land conservation under APP and outside of APP jurisdiction prior to introduction of the monetary incentive (Appendix B). Thus, the introduction of a monetary incentive and especially the interaction with the higher offer disengages demand from those with prosocial motivation. According to Frey's model, the incentive may be seen as undermining their self-determination.

Result 6: The principal matters.

Perception of the government is a significant determinant of accepting the payment. When controlling for opportunity costs and the offer level, an increase in one standard deviation above the mean in the progovernment index is associated with a 7 percent higher probability of accepting the payment for the conservation program (see Table 2.6). If the landholder is assigned to the high offer treatment, a one-unit increase in standard deviation above the mean increases the probability of accepting the payment to 10 percent. For the restoration program, a one-unit increase in standard deviation above the mean in the progovernment index is associated with 8 to 9 percent higher probability of accepting the payment (see Table 2.7).

In our sample, landholders who believe it is the government's responsibility to pay to protect public resources on private and public property have greater demand for PES programs. Higher subsidies further increase demand for PES programs. On the other hand, in more qualitative analysis of the landholders who refused the monetary incentive, we found that 24 percent and 36 percent of the sample offered the conservation incentive and restoration incentive, respectively, stated they were not confident the government program would be implemented, they did not want the government to control their property, or they did not want to be burdened with the bureaucracy. Thus, we learned that the principal matters and eliciting support for, and confidence in, government programs is crucial for increasing demand of PES programs.

Result 7: Monetary incentives can override social norm concerns.

Support for Result 7 comes from Tables 2.6 and 2.7. The payment offer for conservation and restoration incentivises the landholders who are influenced by social norms. Social norms is an index derived from factor analysis and captures those landholders who plan to discuss the project with their neighbour and will enroll in the program if their neighbour enrolls.

However, since the monetary instrument incentivised them to accept before their ability to discuss the project with their neighbour, and without them having knowledge of the decision of their neighbour, the extrinsic incentive may have overridden their social norm concerns. An increase in one standard deviation above the mean in the social norms index leads to a 12 percent higher probability the landholder will accept the incentive for the conservation program, and a 10 percent higher probability the landholder will accept the offer for the restoration program.

Result 8: Information matters.

Support for Result 8 comes from 2.6 and 2.7. Those who have access to general information on PES, information on the specific Mina d'Água PES scheme, and understand the APP law are 5 percent more likely to accept the offer for both the conservation and the restoration program. The results are in line with the findings of Zanella et al. (2014); however, Zanella et al. (2014) conclude that access to information is the most significant determinate of participation over environmental concern. We find otherwise; various motivations and the interaction of motivations with varying levels of incentives are more significant determinants of demand for PES than access to information.

Robustness checks

If we are concerned about the CV design, and in particular if the conditional second bid was not well designed, then an analysis of the first bid alone is needed. We conduct a probit analysis of the first bid for both the conservation and restoration programs. We look at the first bid *level* alone, then a separate specification adding demographics, and a final specification including the intrinsic motivations. We find the results are robust to model specification. The variables of interest retain their significance.

When controlling for demographics (Column V in Table 2.8 and Column V in Table 2.9) and separately demographics and motivations (Column VI in Table 2.8 and Column VI in Table 2.9), the average landholder is less likely to accept the payment when assigned the high offer treatment. When looking at the disaggregated offers, we observe the landholder is less likely to accept when assigned to the third highest bid compared to the lowest bid.

Progovernment (Column VI in Table 2.8 and Table 2.9) and prolegal landholders are more likely to accept the monetary offer (Column VI in Table 2.9). As in the main model, proenvironment landholders are more likely to accept the Restoration bid (Table 2.9) but we do not have enough power to observe the interaction effects when the proenvironment landholder is provided the higher bid treatments. Prosocial landholders, also as in the main model, are less likely to accept the conservation bid (Column VI in Table 2.8). However we cannot observe if refusal increases with higher levels as we do in the main model due again to lack of power.

2.7 Conclusion

In this study, we employ a field experiment to shed light on the determinants of demand for a PES program in the state of SP, Brazil. Our results cast some doubt on a pure rational choice model. We find that demand for PES does not always monotonically increase with the level of subsidy provided. As the offer level increases, the average landholder becomes less likely to accept the payment. Other factors than pure monetary increases are likely at play.

Next, we consider the role of intrinsic motivation in determining demand for PES. Specifically, we use a taxonomy to separate multiple sources of intrinsic motivation: proenvironment, prosocial, progovernment, and social norms. We find evidence of important differences in how types of intrinsic motivation interact with experimental changes in monetary incentives. Landholders who believe the government is responsible for paying to protect water sources (progovernment) are more likely to accept the monetary offer, and their demand increases with the size of the subsidy. In contrast, landholders with prosocial motivations are categorically less likely to accept the monetary incentive, and refusal increases with higher levels of subsidy. Landholders with proenvironment motivations are less likely to accept the monetary incentive at high offer levels.

While the present study provides credible evidence on the interplay of intrinsic and extrinsic motivations in determining demand for a PES program, additional work is needed to understand the dynamic impact of a PES program on conservation behaviour and on preferences and perception over time.

Our findings also indicate that higher levels of knowledge on conservation technologies are associated with higher take up of the PES offer. Financial constraints and undermining the importance of intrinsic motivations may not be the sole sources of inefficiencies in understanding conservation behaviour, and program administrators may consider supplementing their outreach with education campaigns.

However, our results must be taken with caution. While the incentive was randomised which allows us to measure the interplay of incentives and motivations, the CV instrument has shortcomings. In particular, the bid levels are too narrow, and the conditional second bid may not have been able to span the range of respondents' preferences. As responses to the monetary incentive form the basis of the analysis in this chapter, the results need to be interpreted with discretion. However, this would be a larger concern if our results showed that landholders did not accept the incentive at any level, or if there was weak significance of acceptance at high offer levels but not low offer levels. Instead, our results show that landholders are less likely to accept the incentive if in the high offer treatments in comparison to the low offer treatments. Arguably, there could exist a much higher amount that would be accepted more likely than the lowest offer. However the offer amounts were based on bounds determined by costs borne by the government; thus the payment offers are congruent with what the government is able and willing to provide to landholders to conserve. As a robustness check, we conducted an analysis on the first bid alone with the assumption that the second bid was not well designed. The results are stable to model specification.

Overall, we show that considerable heterogeneity underlies demand for PES programs. Some of our results suggest that, at certain levels of subsidization and among certain subgroups, payments may not have additionality. This implies that in order to achieve fiscal efficiency, such programs may consider running randomised controlled trial pilots, varying the subsidy levels and eliciting motivations, to establish the price elasticity of demand in their target population. Such studies, complemented with education campaigns, can be powerful ex ante instruments to improve the design of the subsidy at the pilot stage and ultimately, to improve take-up of well-targeted recipients for the program.

Chapter 3

The Effects of Land Use Regulation on Deforestation: *Evidence from the Brazilian Amazon*[1]

3.1 Introduction

Tropical deforestation is a major contributor to greenhouse gases in the atmosphere, accounting for about 32% of the world's total CO2 emissions during the 1990-2005 period (World Bank, 2010). The importance of reducing deforestation received much recognition in the climate agreement reached in Paris 2015, with 60 countries including REDD (Reducing Emissions from Deforestation and Forest Degradation) in their commitments and a separate REDD-clause in the final agreement (The Economist, 2015). From 2000 to 2012, Hansen et al. (2013) found increasing forest loss in the tropics, driven by countries such as Indonesia, Malaysia and others. In

[1]Co-authors: Liana O. Anderson, National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN); Torfinn Harding, Department of Economics, NHH Norwegian School of Economics, and University of Stavanger; Karlygash Kuralbayeva, Grantham Research Institute, LSE; Andre Lima, Department of Geographical Sciences, University of Maryland. The project is funded by the Research Council of Norway (project number 230860).

contrast, Brazil stood out with the largest decline of all countries globally, with more than halving its annual loss of forest cover from 2003/2004 to 2010/2011. An understanding of the factors behind the Brazilian success could guide the efforts of other countries in reducing their deforestation rates. However, academics are still debating the importance of the different policies and corporate actions that have been implemented since 2004.[2]

In this paper we examine the contribution of forest conservation to the reduction in deforestation in the Brazilian Amazon. As shown in the left panel of figure 3.1, forest under strict regulation (conservation zones) increased from 12% to 22% of the entire legal Amazon area in the period 2003-2010. Many observers assign an important role to this aggressive policy effort in the remarkable drop in deforestation rates over the same period, which can be seen in the right hand side panel of the figure. However, it is clear that most of the drop took place outside of the zones rather than inside of the zones, as the level inside was low also before 2004.

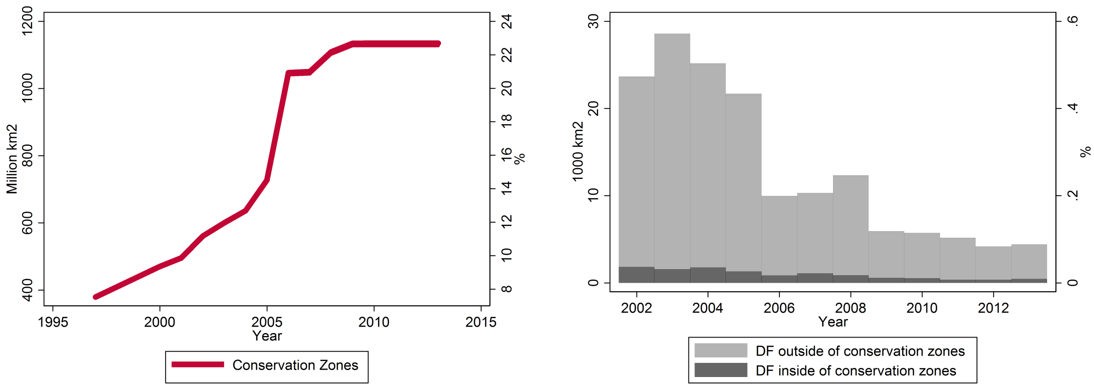

Figure 3.1: Total area covered by conservation zones and deforestation rates

Notes: Conservation zones (left panel) and deforestation rates inside and outside zones (right panel). Zones established in the years 1959-2012. Figure C.1 presents the same graphs including only zones established in 2004-2010. Source: Authors own calculations based on data from INPE.

High resolution spatial data (we use 1 km^2 grid cells) allow us to zoom in and compare areas just inside with areas just outside the conservation zones, i.e. we implement a spatial regression discontinuity design, like Turner et al. (2014). We follow Turner et al. (2014) in focusing on straight parts of the zone boundaries,

[2]See for example the Editorial of Nature April 2nd 2015 and the two Science articles (Gibbs et al., 2015; Nepstad et al., 2014).

to deal with potentially endogenous zone location due to micro variations in the natural geography. The assumption is that nothing in nature is straight, in contrast to policy lines. We focus on zones established from 2004 to 2010, and annual data on deforestation (2002-2013) allow us then to investigate the discontinuities at zone boundaries before and after the zones were established.

Our first empirical finding is that zones in general have not reduced deforestation. Although the areas inside the zones do have lower deforestation rates, with a discontinuity at the boundaries, we find that the discontinuity in deforestation was present also before the zones were established. This observation suggests that the zones did not reduce deforestation. Difference-in-difference estimates, based on the difference between inside and outside cells, before and after zones were established, confirm that zones did not reduce deforestation.

Our second empirical finding is that zones were placed where agricultural production is likely to have low profitability. A linear probability model reveals that the conservation zones established from 2004 to 2010 were likely to be placed away from areas where agricultural production is expected to be profitable. In the same vain, high past deforestation rates also correlate negatively with the likelihood of the area being put under regulation. These results suggest that the location of zones were dominated by minimizing the efficiency loss of the policy, at the expense of the effectiveness of the policy in terms of reducing deforestation rates. In turn, this can explain our second empirical finding.

Our third empirical finding points to the importance of enforcement. It is obvious that enforcement issues matter in designing and assessing any regulatory regime. We exploit a policy implemented by the federal government in 2008, in which municipalities with particularly high deforestation rates were put on a "shame list" and faced the risk of losing federal monetary transfers over the state budget. We find that zones located in municipalities on the list were more effective than other zones.

Our finding that the conservation zones established from 2004 to 2010 play a little, if any, role for the large reduction in deforestation rates observed in the

Brazilian Amazon since 2004, stands in stark contrast to the going conventional wisdom. For instance, Assunção et al. (2015) argue that approximately half of the deforestation that was avoided in the Brazilian Amazon during 2005-2009 was the result of government conservation policies. Soares-Filho et al. (2010) came to a similar conclusion, asserting that the expansion of the protected areas account for 37% reduction in deforestation in the Brazilian Amazon between 2004 and 2006, without facilitating leakage. Nolte et al. (2013) found that protected areas have contributed to reducing deforestation rates. Furthermore, as they compare different types of protected areas, they conclude that strictly protected (SP) areas have avoided more deforestation than sustainable use (SU) areas, with the former being effective under conditions of limited government enforcement. In contrast, our estimates do not reveal any qualitative differences between SU and SP zones.

For countries like Indonesia, Malaysia and Congo, that are in need for policies that can reduce deforestation, this paper contributes by pointing out that conservation zone policies can reduce current deforestation rates if incentives to enforce the regulation are high for the local authorities, and only if they are placed where agricultural profitability is positive.

The first contribution of the paper lies in the empirical identification strategy. The current empirical literature[3] has used matching on observables to deal with the potential non-random selection of zone location. Our empirical design is an improvement over this, as it allows us to take into account selection also on unobservables. Such unobservables are found to be crucial for the location of the zones. For the Brazilian zones established in 2004-2010 that we study, the endogenous selection of zone locations introduces a bias such that zones appear more effective than they are in reality. The spatial regression discontinuity (RD) design in combination with straight borders that we borrow from Turner et al. (2014) aims to account for unobservables in that, close to the border, the factors relevant for deforestation are plausibly the same on both sides of the border. In our context, however, this may not be

[3]e.g., Assunção et al. (2015), Blackman et al. (2015), Bruner et al. (2001), Nolte et al. (2013), Soares-Filho et al. (2010) and Pfaff et al. (2014)

sufficient to deal with unobservables as there is a discontinuity in deforestation also before the zones were established. The difference-in-differences estimation allows us to control for time-invariant unobservables as wells as differential trends inside and outside of the zones. In the absence of randomly placed zones, these strategies give the best hope of achieving unbiased estimates of the effect of the zones. The set of results presented in this paper gives a remarkably consistent picture. Note, however, that had we relied on RD alone, i.e. not brought in the time-variation, we could easily have concluded that the zones did reduce deforestation.

The second contribution of the paper is that we empirically explain the location of the zones. Nolte et al. (2013) also discusses the importance of "deforestation pressure", and our paper complements their paper by adding empirical estimates of key determinants of zone location.

A final contribution is that we take advantage of a program of the federal government that raised the stakes of reducing deforestation for certain municipalities, and show that conservation zones reduced deforestation in incentivised municipalities. This is consistent with Assunção and Rocha (2014), who study the effects of the listing in a municipality-time panel analysis. They find that the listing reduced deforestation primarily through monitoring and law enforcement. Our contribution is to investigate the effect of the listing in the context of zones, zooming in precisely on where the deforestation happened within municipalities.

The rest of the paper is organised as follows. In Section 3.2 we describe the empirical approach and the data. Empirical findings on the effects of zones on deforestation rates are in Section 3.3. Section 3.4 investigates the factors that affect the location of the zones. Section 3.5 examines the role of incentives in reducing deforestation rates in the context of the zones. Section 3.6 concludes with a discussion on the role of conservation zones in reducing deforestation rates in Brazil.

3.2 Empirical strategy and data

3.2.1 Empirical strategy

1. **Effective conservation zones generates a discontinuity in deforestation at zone boundaries**

First we investigate graphically if there is a discontinuity in deforestation at the borders of the conservation zones. This follows a standard spatial regression-discontinuity design, like Turner et al. (2014) and Cust and Harding (2014). For each zone, we know the year of establishment and we look for discontinuities in the period the zone was active, as well as in the years before the zone was active.

To formally estimate the effect of conservation zones, we use a standard difference-in-difference regression (like, e.g., Greenstone et al. (2010)):

$$DF_{pzt} = \alpha + \beta_1 Ever_z + \beta_2 Ever_z x Post_{zt} + \beta_3 Post_{zt} + f(dist_{pz}) + Ever_z * f(dist_{pz}) + Z'_{pzt}\theta + \epsilon_{pzt} \quad (3.1)$$

where p indicates cell, z zone and t year, i.e. grid-cells observed annually are our units of observation and we know whether they are located in an active conservation zone or not. DF measures deforestation in fraction of the area of the cell, $Ever$ is a dummy that takes 1 if the cell will be or is in a conservation zone, $Post$ is a dummy taking 1 for the years the conservation zone is active. β_2, the coefficient on the interaction between $Ever$ and $Post$ picks up the difference-in-difference estimate and is our coefficient of interest. $dist$ is the distance from the cell p to the conservation border. f is a polynomial and we allow for it to have separate effect on each side of the border. We use a polynomial of order 2 in our baseline specification.[4]

Z is a vector of controls for the land rent curve[5]. We interpret agricultural

[4]In an earlier version of this paper, we included separate time-trends inside and outside of the zones, and it did not change the conclusion that zones in general do not reduce deforestation. Given our conclusion of no-effect, we view it as more prudent to not saturate the model with controls, and therefore use a more parsimonious formulation as our baseline model.

[5]Please refer to the full working paper (Anderson et al., 2016) which includes a theoretical

production widely (anything that requires deforestation), and the distance z as the distance to the relevant markets. z also represents anything that is correlated with agricultural productivity. The appropriate measures would in principle vary across agricultural products. We focus on distance to city and soil quality. We also control for the fraction of the cell that is coded as non-forest (water, cities etc.) as well as for lagged forest cover.[6]

β_2 in equation 3.1 is identified to the extent the error term is uncorrelated with the variable $Ever_z$ x $Post_{zt}$. Non-random allocation of zones represents a considerable identification challenge. We control for observables as explained above, whereas unobservables are controlled for by the following. The RD-set up, with the flexible polynomials in the distance to the conservation zone border controls in principle for unobservables in terms of natural geography. The idea is that very close to the border, the natural geography is the same. Furthermore, we follow Turner et al. (2014) and use only straight parts of the borders.[7] The idea is that nothing in nature is straight, in contrast to policy lines. A discontinuity across a straight border is therefore more likely to be related to the policy than a discontinuity across a non-straight border, whose location is more likely to be partly determined by omitted factors in terms of local natural geography. Finally, by bringing in the timing, we can control for municipality-year fixed effects that pick up anything that affects the average level of deforestation in a given municipality in a given year, i.e. we identify β_2 from within municipality variation.[8] In robustness checks, we also present results with cell fixed effects in addition to the municipality year fixed effects. We cluster the standard errors on the level of treatment, i.e. on zone-time, to take into account

section, written by Karlygash Kuralbayeva and Torfinn Harding, which forms the basis for the controls in the empirical analysis.

[6]We have also investigated the role of alternative measures of market access and agricultural productivity, such as the distance to nearest river, distance to nearest soy field, the fertility of the soil and past deforestation rates. The choice of variables to be included in Z does not seem to affect the results. Distance to city is found to be the most robust one.

[7]Borders are defined as straight by the rule used by Turner et al. (2014), see their graph on p. 1374 for an illustration. More details are available from the authors.

[8]Using instead year fixed effects, municipality fixed effects, zone fixed effects, or combinations of the above does not seem to alter the results.

potential Moulton bias and spatial correlation.[9]

The second assumption we test is the location of the zones. Concerns for minimizing leakage of deforestation into previously unprofitable areas push the location beyond the agricultural frontier. The government may also plan "buffers" to future potential deforestation. If, however, the government faces an additional incentive and is forced to reduce *historical* rates of deforestation to some reference point, then the government has to locate the zones inside of the agricultural frontier. In this case, the agricultural frontier is to be located inside the conservation zone.

2. **Economic efficiency concerns push the zone location out of areas with high rents in agriculture, whereas concerns about reducing contemporary deforestation rates push the zones to be located (at least partly) inside the agricultural frontier**

To test this hypothesis, we estimate the following linear probability model:

$$Ever_{pz}xPost_{pz} = \alpha + Z'_{pz}\gamma_1 + \epsilon_{pz} \tag{3.2}$$

Importantly, here we estimate where the zones are located in the cross section, i.e. we limit the sample so all cells are only represented once. We compare in principle all cells across space, and the dependent variable is simply the ever-treated dummy. The first set of determinants are variables correlated with transportation costs and land productivity, representing economic efficiency concerns. The second set is past deforestation rates. A negative effect of past deforestation rates would indicate that economic efficiency concerns are working also through past deforestation (unobserved land rent determinants are captured by past deforestation), whereas a positive effect of past deforestation would indicate that the zones were placed where there had been high deforestation in the past and hence they would be an attempt to curb those rates in the future. We also condition on the initial level of forest cover. The linear probability model reveals how the location of the zones correlates

[9] One could argue that we should implement two-way clustering to take into account serial correlation. However, given our conclusion of no effect, we regard it as more prudent to run with less conservative clustering.

with characteristics such as distances to city, river, nearest soy field, soil quality and past deforestation. The variables are either predetermined or related to natural geography. In the linear probability model, we cluster standard errors on the municipality level to take into account spatial correlation.

The third hypothesis we empirically test is that higher enforcement costs or lower enforcement budgets result in higher deforestation rates within conservation zones. This implies that policy interventions that increase enforcement efforts can result in lower deforestation rates.

3. **The drop in deforestation at the border varies with enforcement**

We take advantage of an initiative from the federal government introduced in 2008, which put a set of municipalities with particularly high deforestation rates on a "shame list" (or "priority list") with the threat of reduction in federal funds for the municipalities' general budgets if deforestation rates did not come down. These municipalities therefore faced higher incentives than others to reduce deforestation and hence may have increased the enforcement of the zones. We expand the difference-in-difference model of equation 3.1 with an interaction term between the treatment dummy and a time varying dummy taking one if the municipality where a given cell is located was on the list in a given year:

$$\begin{aligned} DF_{pzt} = \alpha + \beta_1 Ever_z + \beta_2 Ever_z x Post_{zt} + \beta_3 Post_{zt} \\ + \beta_4 Ever_z x Post_{zt} x List_{pt} + \beta_5 Ever_z x List_{pt} + \beta_6 Post_{zt} x List_{pt} + List_{pt} \\ + f(dist_{pz}) + Ever_z * f(dist_{pz}) + Z'_{pzt}\theta + \epsilon_{pzt} \end{aligned} \quad (3.3)$$

A negative β_4 suggests that the zones reduced deforestation more in the municipalities on the list. To avoid complicated interpretation, we exclude for these estimates zones established after 2008, i.e. in 2009 and 2010. The rest of the set up is identical as for the difference-in-difference estimation described around equation 3.1.

3.2.2 Institutional setting

Brazil was for long the leader in tropical deforestation worldwide, estimated to have cleared an average of 19,500 km^2 per year from 1996 to 2005. In 2008, the Brazilian government committed to reduce deforestation by 80% of the historical baseline by 2020 (Government et al. (2007)). However, efforts started before 2008.

Brazil's law regulating deforestation on private land is the Forest Code (FC), which was created in 1965, and through various presidential decrees in the 1990s it was transformed into de facto environmental law (Soares-Filho et al. (2014)).[10] Even though the FC severely restricted deforestation on private land, it was hardly enforced until Marina Silva became the minister of environment from 2003-2008. In 2003 she launched a National Plan for the Prevention and Control of Amazon Deforestation that ramped up law enforcement and established 600,000 km^2 (roughly the size of France) of new protected areas, with the area in conservation zones adding up to 22% of the Amazon in 2010 (Alarcon-Diaz, 2012). A key component was also to fight illegal deforestation activities.[11]

The Amazon protected areas (PAs) are broadly defined as all public areas under land-use restrictions that contribute to the conservation of the natural resources. In addition to the conservation zones we study in this paper, PAs include indigenous lands and military areas.[12] The conservation zones are managed by the federal, state, or municipal governments, and they are classified into two groups: strictly protected areas (SP) and sustainable-use units (SU). Each group can be further sub-classified into diverse categories, according to the degree of conservation and use(Verissimo et al., 2011). In SP areas, harvesting of forest products or minerals as

[10]The FC establishes a percentage of rural properties to be maintained as a permanent forest reserve. The FC originally dictated that at least 50% of private properties in the country's northern region should be maintained as reserves (Alarcon-Diaz, 2012). Following a major increase in forest clearing rates in the middle 1990s, the fraction of person's property held in reserve has changed. As of 2001, the FC stipulates that 80 percent of Amazon rain forest on private property must be held in reserve, meaning that landowners can clear 20 percent (Soares-Filho et al. (2014).)

[11]See interview with Silva in the Financial Times, October 5, 2009

[12]PAs covered a total area of about 2.2 million km^2 by December 2010, encompassing 43.9% of the territory of the Brazilian Amazon (Verissimo et al. (2011)), with conservation zones accounting for 22.2% and indigenous land covering the remaining 21.7%. From 2004 to 2013, deforestation declined to 35.9% of its historical levels.

well as settlements of traditional and non-traditional populations are not allowed. SU areas are designed for both biodiversity conservation and sustainable extraction of natural resources. In those areas the extraction of timber and other forest products are permitted to some extent under a sustainable management standard. Traditional populations may remain within the area as long as they undertake activities in a sustainable way (Verissimo et al. (2011)). In the late 1980s, the SP areas accounted for the majority of the areas under conservation (92%). Over time, and in particularly after year 2000, the share occupied by SU zones has increased.

The Forest Code also requires that property owners register their land; the system called the Rural Environmental Registry System (Portuguese acronym SICAR), which should improve transparency and compliance. However, as Gibbs et al. (2015) argue property registration does not protect forests. They note that only few registered properties in states such as Mato Grosso (9%) and Para (4%) had the forest cover at least 80% as dictated by the FC. This may be about to change, with recent efforts of implementing comprehensive land registration.

Also the enforcement has ramped up significantly in recent years. Enforcing environmental laws across the huge area as of the Brazilian Amazon is a great challenge for regulators. For instance, the Brazilian regulator (IBAMA) uses satellite data and field visits to issue fines and embargo economic activities on properties with illegal deforestation. However, as Gibbs et al. (2015) note, government's monitoring is limited: as of May 2014, they estimate that "roughly half of the registered properties with deforestation $\succeq$ 25 ha, 2009-2013, were not embargoed".

3.2.3 Data

We study the legal Amazon, an area of 5,032 million km2 in the north and west of Brazil (for comparison, the U.S. area of land + inland water is 9.4 million km^2). The data on deforestation cover the entire area, for the period 2002-2013.[13] These are

[13]In addition, the stock of historical deforestation prior to and inclusive of 1997 has been calculated, as wells as the deforestation that took place between 1997 and 2000. Therefore we observe the stock of deforestation taking place before 2001. 2001 was the first year of annual deforestation data, but we have currently chosen to exclude 2001, as the data suggest very high deforestation

based on NASA satellite images which have been processed at INPE, the Brazilian National Institute for Space Research. They come with high spatial resolution (about 200 meters) and we aggregate them up to grid-cells of 1 km^2.

Using the coordinates of the centroid of the grid cells, we assign geo-specific information, such as distances to city, river, soy fields, road and political boundaries. We also use data on soil quality, stock of forest cover in 2000, lagged forest cover and share of non-forest. For the conservation zones, we observe their exact locations (their boundaries) and the year of establishment. All data come from either INPE or the Brazilian Institute of Geography and Statistics (IBGE).[14]

We focus on zones established in 2004-2010 only, which ensures that we have deforestation data before and after for all the zones.[15] We define "treated" cells as those located within an "active" conservation zone, with active referring to years for which the zones existed. "Control" cells are cells located outside active conservation zones, and we assign each outside cell to its nearest conservation zone. We define the *Ever* dummy as taking 1 for all cells that appear in a conservation zone at some point, and zero for cells that are never in a conservation zones. The *Post* dummy takes 1 for the years a zone is active, for all cells assigned to that particular zone. This set up allows us to compare inside with outside cells, before and after the zone was established.

The deforestation data are recorded as the deforestation from September to August, i.e. the deforestation recorded for the year 2006 cover the deforestation that occurred from September 2005 to August 2006. Since annual zone establishment dates follow the calendar year, we exclude deforestation coded to have happen in the year of establishment (say 2006), to avoid that the deforestation assigned to 2006 in

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rates and closer investigation of the maps reveals patterns we have yet to understand.

[14]Detailed information is available from the authors.

[15]The maximum years we could use before/after is eight/nine. Since there are very few observations in the ends, we use seven years to avoid any influence of outliers: For the RD-plots, we use averages across the 7 years before (t=-7) and 7 years after (t=7), in the regression we use annual data for for 2002-2013 limited to t=-7 and t=7. We always exclude t=0, because the deforestation data is recorded September-August instead of on calendar years, explained elsewhere in this section. An alternative would be to lag the Post-dummy one period, but we find it cleaner to simply exclude the introduction year, $t = 0$.

our dataset occurred before the zone was established.

In terms of the samples, we include in the RD-plots all cells, whereas we include only those cells within 10 km from the border in the difference-in-difference estimation, to make the RD-assumption of identical cells in terms of unobservables more likely to hold.[16]

3.3 Empirical results I: The effect of zones

3.3.1 Graphical evidence

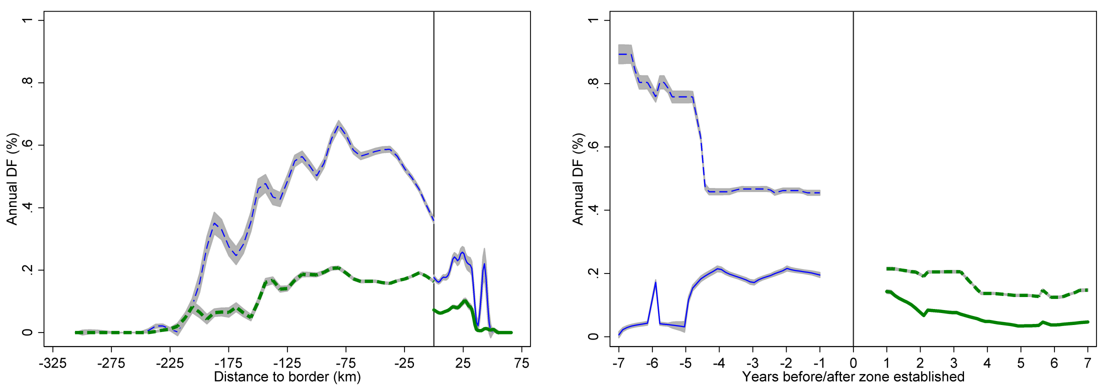

Figure 3.2: Deforestation outside vs. inside and before vs. after

Left panel: Outside (left dashed) vs. inside (right solid), before (thin blue) vs. after (thick green). Right panel: Outside (dashed) vs. inside (solid), before (thin blue) vs after (thick green). We include only cells within 30 km of the conservation zone boundaries.
Mean DF across up to 7 years before and 7 years after. Zones established in the period 2004-2010, DF in t=0 excluded. Inside and outside cells are matched to a given zone, i.e. the timing for the control cells corresponds to the timing of their nearest zone.

The green/thick lines in figure 3.2 plot the deforestation outside (negative distances, plotted the the left) and deforestation inside (positive distances, plotted to the right) of *active* conservation zones. Deforestation is in the graphs measured as the % of the covered area that was deforested annually. There is clearly a drop in deforestation as the border of the conservation zone is crossed from the left to the right, consistent with our assumptions. However, the blue/thin lines show that

[16]We present robustness checks where we vary this between 5 km to 30 km. The deepest zone we have in the data is about 65 km.

the discontinuity was present also before the zones were established, suggesting that the zones were located in areas with low profitability of deforestation. The lower deforestation on both sides of the border in the treatment period (green thick lines), reflects the general decline in deforestation rates in Brazil in our sample period. Note that the drop in deforestation over time is higher outside than inside the zones.

The right hand side panel of figure 3.2 is a difference-in-difference graph, showing mean deforestation over time. Zones are established at $t = 0$. Using the same marking of lines as in the left hand side panel, solid lines show the deforestation rates inside the zones, which are lower than the outside deforestation rates (dashed lines). Outside, there was a downward-sloping time trend over the entire period, whereas inside, the negative trend seems to have started around $t = -2$. After the zones were established, the trends are similar outside and inside, with deforestation rates levelling out on relatively low levels, i.e. about 0.2% a per year outside and 0.1 % per year inside the zones. In terms of the effect of the zones, i.e. the drop around $t = 0$, we observe again that the drop in deforestation is larger for the outside cells than for the inside cells. It is not clear that there is a discontinuity around $t = 0$. Next, we investigate this more formally by estimating a difference-in-difference model.

3.3.2 Econometric estimates

Table 3.1 presents estimates of equation 3.1. Our assumption that deforestation drops at the border of conservation zones under non-zero enforcement, is tested by the parameter on the ever-treated dummy ($Ever$) interacted with the post dummy ($Post$), β_2. Focusing on column 1, which pools SP and SU zones, the second row shows a non-significant β_2. The ever dummy always takes a negative and significant coefficient, indicating that deforestation inside the zones was always lower than outside of the zones.

In contrast, Nolte et al. (2013) find that conservation zones have reduced deforestation in Brazil. Furthermore, they find that strictly protected (SP) zones have been more effective in doing so than the sustainable use (SU) zones. Column 2 and 3 present estimates for the two types of zones separately, without revealing any qualitative difference between them.[17]

Table 3.1: Difference-in-Difference estimates of the effect of zoning

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0010*	-0.0025***	-0.0004
	(0.0005)	(0.0009)	(0.0006)
D=1 ever in CZ x Post	0.0007	0.0010	0.0005
	(0.0006)	(0.0007)	(0.0007)
Post	-0.0014	0.0002	-0.0011
	(0.0009)	(0.0012)	(0.0012)
Observations	1 033 058	282 701	747 769
R-sq	0.037	0.013	0.043
Clusters	877	207	680
Meters from CZ incl.	10 000	10 000	10 000

Notes: ***p <0.01, **p <0.05, *p <0.10. Standard errors clustered at zone-t level. Based on t +/- 7 years max, zones 2004-2010, straight borders only. Dependent variable: DF, i.e. the share of a 1 km^2 cell, the unit of observation, that is deforested in a given year. *Ever* is a dummy taking one for all cells ever to be located inside one of the zones we consider and zero for cells outside the zones, *Post* is a dummy taking one for years when a given zone is active (both for inside and outside cells assigned to that zone), and the interaction $Ever * Post$ picks up the difference-in-difference effect of interest, β_2. We control for, separately on each side of the border, second-order polynomials in the distance to the border. In addition we include as controls the log distance to nearest city, lagged forest cover and share of non-forest at the cell level, and municipality-year fixed effects. See appendix table C.1 for the full table. All refers to all zones, SP to strictly protected zones and SU to sustainable use zones.

Zones may reduce deforestation rates only if deforestation would be profitable without the conservation zones. To test this assertion, we interact in table C.2 the treatment variable *Ever x Post* with an indicator of the soil quality. The soil quality is based on natural geography. To simplify the interpretation, we use the average soil quality across all cells within a municipality as the measure. In addition, we subtract the average soil quality, so the variable can be interpreted as the deviation from the average soil quality. For the SP-zones, the interaction with the ever treated dummy is positive, whereas the coefficient on the interaction with the treatment variable is negative. This indicates that the deforestation before the zones became active was higher in areas with high soil quality and that the activation of the zones did reduce deforestation in such areas. The coefficients for "All" and "SU" are insignificant.[18]

[17] Appendix figures C.1 and C.2 present graphs for SP and SU separately. The figures show that the pattern of deforestation is not strikingly different across the two types of zones, except that deforestation is markedly lower inside of SP zones, after the zones have become active. This is consistent with the regulation, which permits some deforestation in the SU zones, subject to a licensing process.

[18] Using alternative measures of agriculture productivity has not produced robust results.

We present a large set of robustness checks in the Section B in Appendix C.1. In table C.3-C.5 we demonstrate that the results of no effect of zones are robust to changing the set of controls. The only exception is when we include cell fixed effects and lagged forest cover as a control. We then identify β_2 from variation across time for each 1 km^2 cell (conditional on the forest cover in the previous period and municipality wide time shocks). In other words, the fixed effect result is necessarily driven by cells in which the deforestation actually changed over time. This points to zones having an effect when they are placed where there is some deforestation to reduce.

In tables C.6 and C.7, we vary the distance from the borders of the conservation zones, down to 5 km and up to 30 km, respectively. The picture is still the same, perhaps with the exception that 30 km produces a significant positive β_2 for SP zones. Finally, table C.8 presents estimates of our baseline model based on all borders, instead of only straight borders. β_2 is positive and significant for the full sample and for the SP-zones separately. The positive β_2 may reflect a larger reduction in deforestation outside compared to inside the zones, consistent with for example figure 3.2.

Our overall conclusion from the evidence presented in this section is that the zones have not reduced deforestation in general. But SP-zones located in areas with high soil quality seem to reduce deforestation rates. In the next section we study where the government choose to place the zones.

3.4 Empirical results II: The location of zones

If a reduction in DF-rates matters to the government, conservation zones must lie partly inside agriculture frontier. In this section, we test this assumption by first showing graphical evidence on where the zones are and by describing the zone locations by estimating a linear probability model (LPM). In the latter, we consider variables correlated with land rent, such as distances to soy field, city, river as well as the quality of the soil and past deforestation. If the latter takes a negative sign, the zones are located away from where deforestation is profitable. On the other hand, if it takes a positive sign, it is indicative of the government strategically placing the zones where they could bite and reduce deforestation.

Appendix figure C.3 shows the zones on a map, together with current deforestation rates in 2005 and 2008.[19] It seems zones have been placed as buffers.

Table 3.2: Linear probability model of zoning

	(1) D=1 if inside CZ	(2) D=1 if inside SP	(3) D=1 if inside SU
ln Dist soy (-1)	0.0058	-0.0027	0.0079*
	(0.0064)	(0.0033)	(0.0045)
ln Dist city	0.0877***	0.0549***	0.0455***
	(0.0213)	(0.0158)	(0.0128)
ln Dist river	-0.0009	0.0055	-0.0049
	(0.0049)	(0.0036)	(0.0047)
DF (-1)	-0.1285***	-0.0505***	-0.0931***
	(0.0337)	(0.0132)	(0.0305)
DF (-2)	-0.1034**	-0.0486***	-0.0677*
	(0.0434)	(0.0142)	(0.0396)
Soil quality (1-8)	-0.0033	-0.0034	-0.0006
	(0.0067)	(0.0040)	(0.0048)
RF 2000	0.0596**	0.0197	0.0484**
	(0.0243)	(0.0152)	(0.0196)
Constant	-0.9111***	-0.5617***	-0.4836***
	(0.2519)	(0.1961)	(0.1391)
Observations	4 242 278	3 906 500	4 030 014
Clusters	742	742	742
R-sq	.0923	.0648	.0507

Notes: ***p<0.01, **p<0.05, *p<0.10. Standard errors clustered at the municipality level. Dependent variable: Dummy taking 1 if the cell was located in a zone established in 2004-2010, and zero if a cell was outside any zone in 2010 or before. Lagged *DF* are for 2002-2003 and initial *RF* is for 2000.

The evidence presented in table 3.2 points to zone locations away from where agricultural production is expected to be profitable, as variables presumably positively correlated with agriculture profitability predict low likelihood of zoning. E.g., the closer to a soy field or a city, the lower the likelihood of the cell to be subject to zoning, and the higher the past deforestation rates, the lower the likelihood for zoning. These results suggest that the location decisions for the zones were dominated by minimizing the efficiency loss of the policy, at the cost of the effectiveness of the policy.

[19] We would like to thank Julika Herzberg for producing these maps.

3.5 Empirical results III: Incentivicing municipalities

As exogenous variation in enforcement efforts are hard to come by, we present in this section indirect evidence on the role of enforcement. In 2008, the federal government established a list of municipalities, called priority municipalities (MPs), that should significantly reduce deforestation. The incentives for the municipalities on this priority list to reduce deforestation were high, as they ran the risk of losing federal monetary transfers over the state budget. These municipalities were subject to more rigorous environmental monitoring and law enforcement from Brazil's environmental protection agency, IBAMA, as well as being subject to fines, embargoes of farms and changes in subsidised credit contracts.

Figure 3.3 presents the difference-in-difference graph for the priority municipalities (SP left hand side panel, SU right hand side panel). The priority municipalities had much higher deforestation rates inside the zones, especially before the zones were active, compared to the other municipalities (see appendix figure C.4 for a comparison with the non-listed municipalities). From the right hand side panel of figure 3.3, it seems that the effectiveness of the zones have increased over time for the SU zones, consistent with the introduction of the list at some point for $t > 0$.

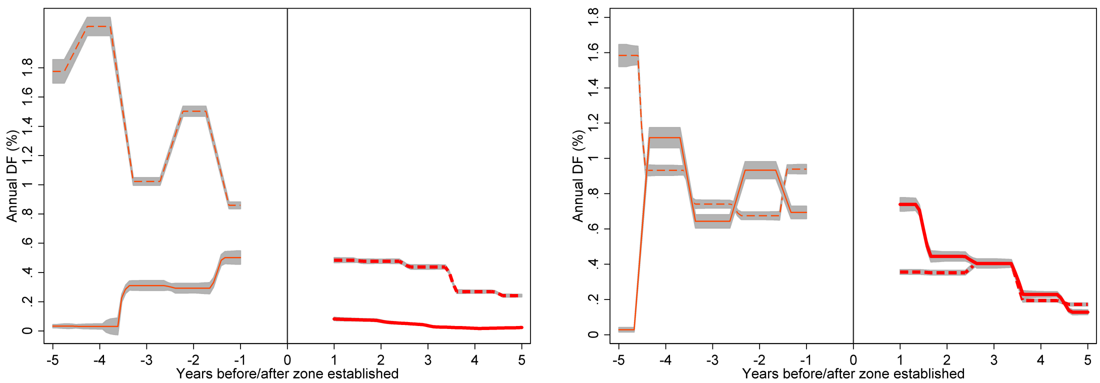

Figure 3.3: Priority municipalities

Left panel SP-zones, right panel SU-zones; otherwise as figure 3.2. Dotted lines are outside and thick lines are inside. Figure C.4 includes also the non-priority municipalities, for comparison. We cap the figure at five years before/after, as we have little data for 6 and 7 years before.

To test if getting on the priority list made the zones bite more, we expand the model from table 3.1 by including an interaction term between our treatment variable, *Ever x Post*, and a dummy taking 1 for the years the municipality was on the list. We estimate this model on the sample of municipalities that were on the list at some point. The results, presented in table 3.3, reflect what we already saw in figure 3.3. The list seem to have made no difference for the SP-zones, but for the SU-zones, getting on the list corresponds with a reduction in deforestation inside the zones (the coefficient on the triple interaction term is negative and significant). Note also that the deforestation rates inside the SU-zones is higher than outside before the list was introduced (the coefficient on the treatment variable is positive and significant), again this can also be seen in figure 3.3. As deforestation in SU-zones may be allowed subject to a licensing process, this may indicate lenient licensing practices in these municipalities. The enhanced effect on SU-zones may have worked via better enforcement and/or less lenient licensing practices. We do not observe either enforcement efforts or licensing practices directly.

Assunção and Rocha (2014) argues that the MPs policy significantly reduced deforestation in municipalities that were responsible for an important part of deforestation in the Brazilian Amazon. They control for the number of fines applied by IBAMA to show that the list-policy worked through increased monitoring and better targeting of law enforcement in these municipalities, and not through other consequences of being on the "shame" list, such as political and economic sanctions.

In table 3.3, only listed municipalities are included. In the online appendix, table C.9 presents results where also the other municipalities are included. We then find that the extra effect in the listed municipalities of SU-zones loses its significance. For SP-zones, the coefficient on the interaction dummy now turns negative and significant, while β_2 turns positive and significant.

Tables C.10, C.11 and C.12 present robustness tests with respect to different distances to the zone boundaries and to the inclusion of also non-straight borders. The significance of the triple interaction term for SU-zones is fragile, whereas the

Table 3.3: The priority list

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0031	-0.0085**	-0.0025
	(0.0021)	(0.0040)	(0.0027)
D=1 ever in CZ x Post	0.0038	-0.0003	0.0060*
	(0.0026)	(0.0032)	(0.0032)
D=1 ever in CZ x Post x pr_post	-0.0010	0.0028	-0.0026**
	(0.0012)	(0.0022)	(0.0011)
Post	-0.0058	0.0010	-0.0099*
	(0.0039)	(0.0034)	(0.0054)
Observations	229 444	69 354	159 157
R-sq	0.038	0.017	0.044
Clusters	280	84	186
Meters from CZ incl.	10 000	10 000	10 000

Notes: ***p <0.01, **p <0.05, *p <0.10. Standard errors clustered at zone-t level. Based on t +/- 7 years max, zones 2004-2008. Includes on each side of the border separate second-order polynomial in the distance to the border, in addition to log distance to nearest city, lagged forest cover, share of non-forest and municipality-year FE. The priority list started in 2008, and for simplification we drop in this part of the analysis zones established 2009-2010. *Post x pr_post*, $D = 1$ *ever in CZ x pr_post* and *pr_post* drop out because of municipality-year fixed effects.

results for the SP-zones are robust.

3.6 Concluding remarks

Throughout the 2000s, the Brazilian government sought to halt forest clearing by assigning conservation zones to large areas in the Brazilian Amazon. In this paper we assess the effectiveness of this policy. We use high-resolution satellite data on deforestation over 2002-2013 and study the effects of zones established in the period 2004-2010. We implement regression discontinuity design and difference-in-difference estimation to identify the effect of the zoning policy on deforestation. In general, the zones did not reduce deforestation, as they were typically placed in areas where deforestation most likely would be unprofitable also in the absence of zones. When zones were placed in areas where deforestation had been profitable in the past, they did reduce deforestation. Furthermore, when the municipalities hosting the zones were faced with high incentives to reduce deforestation, zones were found to be more effective.

The major identification challenge we face in estimating the effect of the conservation policy is that the zones may not be randomly located. It would be ideal to have an instrument that determines the location and timing of zones that was excludable from equation 3.1. In the absence of such an instrument, we deal with the potential endogeneity in the estimation of β_1 in equation 3.1 by the RD-design and by controlling for unobservables in terms of past deforestation rates and various fixed effects. The spatial RD-design helps in principle with controlling for selection on unobservables, as cells at the border should be the same on each side. We follow Turner et al. (2014) in focusing on straight parts of the zone boundaries, to deal with potentially endogenous zone location due to micro variations in the natural geography. However, there may be that the border locations do correlate with unobserved factors that are relevant for deforestation and that vary discontinuously at the border. The RD-assumption may then not be valid. We therefore bring in timing and estimate the difference-in differences model. This controls for unobservables inside versus outside by the ever-treated dummy.

In spite of such local successes in reducing deforestation, our findings point out that factors beyond the zoning policies are needed to explain the large decline in deforestation rates seen in Brazil since 2004. This is clearly seen in the right hand panel of figure 3.1 and in figure 3.2, as most of the reduction in deforestation took place outside rather than inside the zones. We leave the important task of identifying these factors for future research.

Chapter 4

Behavioural Interventions for Conservation: Experimental Evidence from South Africa[1]

4.1 Introduction

Public utilities need to consider the moral imperative of providing subsidised (or free) services to extremely poor households against the environmental imperative of encouraging efficient resource usage. As a country in the grip of one of the worst droughts in decades, while also being one of the most unequal societies in the world, local municipalities in South Africa have the challenge of balancing these competing objectives. Even after more than two decades since Apartheid ended, South Africa has an income Gini coefficient of around 0.70 (World Bank, 2016). The top 10% of the population accounts for around 75% of the country's wealth and 58% of income (World Bank, 2016; Suisse, 2015). In this context of extreme water scarcity coupled with high income inequality, behavioural nudges may be a useful adjunct to traditional DSM for three reasons:

[1]Co-authors: Kerri Brick, Environmental Policy Research Unit (EPRU), University of Cape Town; Martine Visser, School of Economics, University of Cape Town. I gratefully acknowledge funding from the European Commission's Seventh Framework Programme for the the Marie Curie Initial Training Network for the Policy Design and Evaluation Research in Developing Countries (PODER) project, and from the South Africa-Norway Research Cooperation.

Firstly, traditional demand-side-management (DSM) tools, such as tariff hikes and water restrictions can feel punitive for poor households and, while applied equally, their outcomes are regressive (for example, poor households do not have the means to soften the financial burden of an increase in tariffs through investments in technology) (Datta et al., 2015)[2]. In contrast, as non monetary incentives do not feel punitive, they can be applied across the income spectrum.

Secondly, as 36% of water is provided free of charge and consumption in the first two of six tariff blocks is subsidised for all income groups (pers. comm, Palmer Development Group (2016)), low-income households - who are heavily subsidised and thus may not internalise financial incentives- might respond more to non monetary incentives.

Finally, revenue from the sale of utilities (water and electricity) provide (part of) the funding needed to supply free basic services. In South Africa, as 25% of revenue comes from consumers in the highest tariff block, local authorities need to prioritise DSM interventions that elicit a more balanced response across the range of users (pers. comm, Palmer Development Group (2016)). DSM initiatives that mainly elicit responses from high users will reduce revenue while interventions that elicit responses from low users will be revenue neutral.

Against this background, we conduct a large-scale behavioural intervention around water conservation. More specifically, using inserts in monthly utility bills, we test seven behavioural messages in a randomised control trial on the entire population of residential households in Cape Town (334 475 households[3]). Our objectives are to firstly determine which causal mechanisms best motivate behavioural change and, secondly, examine how treatment effects vary across income groups. In particular, we examine how responsiveness to financial incentives, information provision and social preferences varies among income groups.

[2]See also Letsoalo et al. (2007) for analysis on triple dividend of water policy in South Africa.

[3]Not included in this analysis are two additional treatment arms, which bring the total sample size to 412 418 households. The two last treatment arms are variations of the financial savings and social recognition treatments, and are analysed in separate papers. See Chapter 5 for results on the social recognition treatments.

The treatments are classified into seven groups:

1. Pure information provision: the tips treatment provides tips on how to conserve water;
2. Price salience: the tariff graph treatment provides a visual of the nonlinear pricing schedule and situates the household's consumption within the stepped-tariff schedule;
3. Financial savings: the financial gain treatment quantifies the financial savings associated with efficient water usage;
4. Social comparison framing: the social norm treatment compares a household's consumption to the average household in their neighbourhood;
5. Neutral framing: the treatment appeals to intrinsic motivation by mirroring the public water savings campaign which asks citizens to reduce water consumption by 10% (no extrinsic incentive is offered if household reduces water consumption);
6. Social recognition framing: the treatment publicly recognizes households who conserve water; and,
7. Public good framing: as water scarcity is a classic public-good dilemma, the public good treatment appeals for voluntary contributions to the public good.

This design enables us to unpack which of the seven mechanisms above - which are explained more fully in the next section - best motivate behavioural change in a context of extreme inequality. Our contribution is two-fold. Firstly, we disentangle and identify the casual chain underlying which incentives most strongly lead to behavioural change. Secondly, we analyse the effect of different nudges across income groups given the high levels of income inequality.

On average, the social recognition treatment had the largest effect, reducing consumption 520 litres on average each month (equivalent to a 2.2% decrease in consumption from the baseline mean). Importantly however, we find contrasting heterogeneity effects across income groups: financial incentives work only on the lower income groups, whereas social incentives (social norms, social recognition, and appeals to their intrinsic motivation) work only on the higher income groups[4]. The average treatment effect for the financial incentives mailer was a reduction of 300 litres each month, equivalent to a 1.3% decrease in consumption. However for the poorest households (excluding indigents), the financial savings insert resulted, on average, in 600 litres of water saved per month (equivalent to a 3.3% decrease in consumption from their baseline mean).

Social recognition reduced consumption by approximately 900 litres each month on average in the highest income group (2.6% decline from their baseline mean), whereas the treatment resulted in an average *increase* of 550 litres for indigent households[5]. This is a crucial finding from a public policy perspective given that understanding heterogeneous responses to behavioural nudges improves the cost-effectiveness of these types of interventions (Ferraro and Miranda, 2013). Specifically, these interventions are low cost - our cost-effectiveness estimate per household is R0.007 (USD 0.0006)[6] for the social recognition treatment- and, it can be targeted efficiently: for example, wealthy households households who are less likely to be responsive to price signals given the relatively smaller share of their budget allocated to water are extremely responsive to the social recognition treatment as opposed to financial incentives. Targeting is also crucial in order to not undermine the behaviour of sub populations who respond negatively to the incentive (such as indigents in the social recognition treatment[7]).

The rollout of this intervention coincided with a city-wide water conservation

[4]Ferraro and Miranda (2013) similarly find that wealthier households tend to be more responsive to social comparisons relative to low-income households.

[5]see Descriptives for more information on the indigent sub population

[6]We took the total project costs including researcher time and divided it by the number of treatments. Then we divided this amount by the litres saved in the treatment per household per month times the number of households in that treatment group for a rough cost estimate for a particular treatment. This is a conservative estimate because we took total project costs over 9 months and divided it by the average monthly decrease.

[7]Please see Chapter 5 for a deeper analysis on the social recognition treatment as it is outside the scope of this paper.

campaign, the implementation of tighter restrictions in water usage and a tariff hike. As such, reduction in consumption represents additional water savings, i.e. water savings on top of those savings directly attributable to the campaign, water restrictions and tariff increase (as we used a randomised control trial, these interventions are internalised in the control group). The finding of significant treatment effects on top of water austerity measures emphasises the general usefulness of behavioural messaging as an adjunct to traditional DSM tools and, more specifically, their usefulness in reinforcing DSM measures in times of extreme water scarcity.

Our study contributes to the literature on social norms and conservation (Allcott, 2011; Ferraro et al., 2011; Ayres, 2010). We find that our treatments have very different effects compared to each other, across income groups, and compared to the existing literature. Following the contribution from Allcott (2011) and others, we tease out the mechanisms (and test additional mechanisms) leading to behavioural change in U.S. home energy and water reports[8] and find in our setting that the treatment traditionally identified as the most important - social norms - is less important than the other mechanisms at play (specifically, social recognition and financial incentives).

The main contribution of this paper is that we use a city-wide randomised control trial to test behavioural theories, some of which have yet to be empirically tested in the literature and some of which have only been tested in a developed country context. Applying behavioural nudges in a developing country context beset by egregious inequality provides not only an opportunity to test the external validity of behavioural nudges but most importantly an opportunity to provide timely evidence for policy makers during an extreme environmental (water) crisis.

The rest of the paper is structured as follows: Section 4.2 presents the causal mechanisms we empirically test with the experiment; Section 4.3 lists the treatments; Section 4.4 describes the experimental design and setting; Section 4.5 shows descriptives; Section 4.6 analyses the pre trend analysis; Section 4.7 details the

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[8]See Appendix D.1

empirical strategy; Section 4.8 discusses the results and Section 4.9 concludes.

4.2 Causal Mechanisms

Inexpensive, non-price and non-regulatory based behavioural interventions are increasingly being seen as a means to promote proenvironmental behaviour (Ayres, 2010); and, in particular, information-based schemes have become increasingly popular in public policy (Thaler and Sunstein, 2008). In the context of reducing energy and water consumption, many studies have appealed to social norms to reduce consumption: for example, Allcott (2011) tests a behavioural intervention by home energy report company Opower across the U.S. and finds that using social norms results in an average decrease of 2% in energy consumption consistent over a two-year period, which is equivalent to a short run electricity price increase of 11-20%. Ferraro et al. (2011) use social norms messaging to reduce water consumption and find that the impact (4.8%) can be measured two years after the study. While these studies attribute the impact on conservation to households adjusting behaviour according to social norms, the studies test multiple channels at once and the results inspire further investigation of the mechanisms causing behavioural change. For example, refer to an average Opower bill in Appendix D.1, and D.2 (page 241). Within the same bill, it details: the comparison of the household's consumption to that of i) their most efficient neighbour, ii) all neighbours, in addition to iii) historical comparisons over 12 months, and v) financial savings tips and smart investments. Where interventions combine private consumption feedback, average neighbour consumption feedback, and monetary incentives (price savings) as well as information, the channel(s) through which households are most motivated to change behaviour is confounded.

We consider the primary causal channels most prevalent in the literature and relevant in the context of water usage:

1. Individuals are motivated by self-interest. However, decisions on water and/or

energy consumption are affected by information constraints. People have limits either to information or to the cognitive ability or resources to make decisions based on full information. In the context of water consumption, either households are unaware of savings opportunities such as savings tips, or are subject to heuristic biases. Consumption is often unobservable (toilet flush, washing machine, irrigation, and leaks); even in cases where usage is visible, it is not always easily quantifiable, for example a shower. Quantifying the water used by appliances, toilets, irrigation systems and showers can be complex and costly. As a result, as a de facto unobservable characteristic, water efficiency receives less weighting than other preferences (for example, when purchasing new appliances (Ramos et al., 2015)). Anecdotal evidence from focus groups held in Cape Town indicates that consumers are not aware of the quantity of water that they use.

Hypothesis: *Decisions on water consumption are affected by information constraints. By making the volume of everyday water use more transparent and offering water savings tips, households will optimise their water consumption.*

2. Individuals may respond to increased transparency on the tariff structure and their usage. More specifically, the choice environment is complex given the opaque and nonlinear tariff structure used by most utilities, ostensibly to promote water conservation, and the fact that in many instances, water usage is not quantifiable or even visible. This is compounded by that fact that, with a conventional meter, households pay for water at the end of the billing period and not during the instance of usage. Thus prices and usage are not salient. Anecdotal evidence from focus groups conducted in Cape Town indicated participating households do not look at their usage within the tariff system, but purely at the amount they owe. These factors imply that the potential for the stepped tariff to induce more efficient usage is not being optimally exploited. A number of studies indicate that individuals under react to non-

salient prices (Chetty et al., 2009; Hossain and List, 2012). Borenstein (2009) found unless customers have full comprehension of the tariff structure and are aware throughout the billing period of the marginal price corresponding to their real time consumption, they are unlikely to be responsive to marginal price increases[9]. Gaudin (2006) finds that elasticity of demand increases by at least 30% when price information is provided on the bill. Kahn and Wolak (2013) use a customised online education program to inform customers of the nonlinear price schedule on their monthly utility bill and find the education program reduces daily consumption by 1.5% - 3%. Their study emphasises the importance of providing timely information on the nonlinear pricing structure for utilities to increase effectiveness of these pricing schemes. We contribute to this literature by sending households regular feedback on both price and consumption (and making both more salient) in the City of Cape Town. The tariff graph treatment might provide a private signal whereby utility maximizing households get closer to their private optimal water use.

Hypothesis: *By making the tariff structure and nonlinear pricing more salient - that is, the more water used, the higher average price paid - and showing where the household's monthly consumption lies within the tariff structure, households will be more responsive to the pricing structure and ultimately reduce usage.*

3. Financial incentives motivate households to reduce consumption. If individuals are self-interested profit maximizing rational individuals, they chose their water consumption level based on financial cost-benefit analyses. If they are limited in their understanding of financial gains from conservation, then the financial framing should have the greatest effect on water conservation.

   Hypothesis: *By making explicit the financial gains from moving into the lower tariff block, budget constraint households will reduce their consumption.*

[9]Many studies studies have shown that in these cases, consumers are more responsive to average price than marginal price changes (Ito, 2014; Wichman, 2014), however we do not exploit differences between average and marginal price in this paper.

4. Social comparisons provided in the social norm treatment facilitate social (observational) learning about the households' privately-optimal level of water usage (Allcott, 2011; Cai and Chen, 2009). Allcott (2011) and Ferraro et al. (2011) find that social-norm based appeals reduce U.S. energy and water consumption by 2% and 4.8%, respectively. Similarly, and consistent with earlier findings in the literature, Smith, G., Visser (2010) show that reporting social comparisons may be an effective way to mitigate household electricity consumption in South Africa. As the success from using social norms has been well documented, we use this framing as a benchmark for which to compare the effect of other treatments.

   Hypothesis: *By providing a reference point as the social norm, households will converge to the reference point.*

5. People are intrinsically motivated whereby they derive utility from the act of giving (Andreoni, 1990). The City of Cape Town initiated a Water Savings campaign asking citizens to conserve 10% of their current water consumption during our study. In line with the public campaign, we appealed to households' intrinsic motivation with a neutral framing by asking them to help save water by conserving 10% of their current water consumption in the summer months. There is no extrinsic incentive provided if they manage to conserve by 10%.

   Hypothesis: *Households will reduce their consumption during drought if they are intrinsically motivated to do so.*

6. Social pressure often encourages people to do good deeds especially if the deed is honorable in the society (Batson et al., 2003; Freeman, 1997; Bénabou and Tirole, 2006). Public recognition has been used in a variety of settings from blood donations to charities to the workplace. In the context of conservation, Yoeli (2009) studies take of up energy savings technology in California. When framed as a contribution to a public good, customers whose decision is publicly visible are 1.5% more likely to sign up than those whose decision is anonymous. Delmas and Lessem (2014) incentivise energy conservation in

college dorm rooms. While private information alone was ineffective, public information combined with private information led to a 20% reduction in electricity consumption.

Hypothesis: *By making household water consumption observable during drought, households will be motivated to reduce their consumption to seek praise and/or to avoid shame.*

7. The public good appeal might alter the moral cost of water usage or, alternatively, generate conditional cooperation whereby households alter their usage in the belief that other will also do so (Allcott, 2011). Water saving is a public good: while it's well known that a significant reduction in water consumption at an aggregated level is needed to reduce the impact of the drought on availability of water for all, the benefits of water savings are shared equally by all households within the municipality irrespective of individual contribution. The incentive is to free ride (Hardin, 1968; Hasson et al., 2010; Brekke and Johansson-Stenman; Brick et al., 2016b). Similarly, in the context of lab experiments, while the dominant strategy in linear public good games is for each player to contribute nothing, subjects make positive but suboptimal contributions to public goods (Cherry et al., 2005), implying that it might be possible to leverage water scarcity as a public goods dilemma to incentivise conservation.

   Hypothesis: *If households are concerned about maximising collective wellbeing, appeals to the public good will motivate a reduction in water consumption.*

4.3 Treatments

In the following section, we introduce the seven treatment arms. The treatments are inserts delivered with the monthly bill, and are designed to test the seven hypotheses from Section 4.2 and are ordered respective to the causal mechanism listed above.

See an example of the City of Cape Town household municipal bill in Appendix D.2. The messages sent with the bill are randomised across the entire sample of domestic free-standing homes in the City of Cape Town with each household receiving only one message throughout the treatment period. Please see Section 4.4 for details on the experimental setting.

Message 1: Tips In the tips treatment, households were provided with water conservation tips in a one-page insert. This information was adapted from City sources (City of Cape Town, 2011b) and was thus widely available. Each tip is presented using a descriptive icon, a short sentence and a paragraph quantifying the potential water savings (liters/month for an average family of four) when the tip is followed. Following Allcott (2011), the tips were divided into quick fixes and smart purchases. Quick fixes include: take short showers, don't leave taps running, have a smaller bath, fix leaks immediately, practice water-wise-gardening; smart purchases include: use a water-saving showerhead, fit taps with water-saving devices, reduce the water used per flush, use pool of cover. The tips treatment is repeated in all subsequent treatments to control for availability of information: if households are motivated to change behaviour due to the insert, then all households across treatments should be provided examples of ways to conserve water. An example of the tip sheet is provided in Appendix D.5 (page 246).

Message 2: Tariff graph Tariffs are priced according to six tariff blocks ranging from zero to R33.59 per kl (City of Cape Town, 2015b). The second treatment augments treatment 1 by providing a graphical breakdown of the household's bill and tariff structure. As evident from Appendix D.7, the insert provides information on: (i) the tariff rates, (ii) the tariff structure and, (iii) where the households' consumption falls within the six tariff blocks. The insert includes the tip sheet in treatment 1 on the back of the page. See Appendix D.7 (page 248).

Message 3: Financial Framing In the financial treatment, we test whether households are most responsible to financial savings from conserving water versus the various social preference treatments. To note, the financial gains includes the graph treatment, with additional details on how much the household could gain financially from moving into the lower tariff block. In this way, the link between efficient usage and financial savings is made explicit. The insert is provided in Appendix D.9 (page 250).

Message 4: Social Norm message The social norm message graphically compares the household's average daily water consumption to that of the average for the neighbourhood. This comparison is presented in both a descriptive text and a bar graph. The insert is illustrated in Appendix D.11 (page 252).

Message 5: Intrinsic motivation This treatment asks households to voluntary reduce their water consumption by 10% in order to support a water saving initiative that was recently launched by the City. Thus there is no direct external incentive for the household to save other than being intrinsically motivated to do so. The insert is provided in Appendix D.13 (page 254).

Message 6: Social recognition As with Message 5 (Intrinsic motivation), this treatment encourages households to reduce their water consumption by 10% in order to support a water saving initiative that was recently launched by the City. However, in addition, the message further states that households that achieve this goal over a six-month period will be publicly recognised on the City's website. The names and suburbs appeared on the City's website four months after the completion of the study, to allow time for households to opt-out if they did not want to have their name displayed publicly. In comparison to message 5, where the motivation to conserve water is internal, this framing explores whether the opportunity to be socially recognised as one of the best performers (water savers) promotes conservation. If people desire to appear to society that they are doing good deeds, then it follows that the opportunity to be socially recognised promotes conservation. See Appendix D.15 (page 256).

Message 7: Public good The message highlights the public good context by encouraging households to voluntary reduce their water consumption in order to reduce the stress on water resources and prevent future water restrictions. See

Appendix D.17 (page 258).

4.4 Experimental Setting

The City of Cape Town municipality governs Cape Town, South Africa. The population in Cape Town is around 3.7 million, with around 1 million households (City of Cape Town, 2011a). As a water-scarce country, South Africa must apply its available water resources in the most efficient and equitable manner possible (Van Zyl et al., 2008). In its Water for Growth and Development Plan, identifying water scarcity in major urban centres, the Department of Water Affairs has highlighted the importance of water conservation and demand management and, specifically, "nurturing attitudinal and behavioural changes towards the value of water" (Department of Water and Sanitation, 2009). More specifically, as the residential share of national water usage is projected to reach around 35% by 2025 (Department of Water and Sanitation, 2009), it is becoming increasingly important for local government to engage with residential consumers around their water usage. As previously discussed, water is priced according to an inclining block tariff structure consisting of six tariff blocks: consumption in the first block is free (up to 6 kl) with tariff rates increasing to R33.59 (excluding VAT) in the sixth tariff block (consumption in excess of 50 kl) (City of Cape Town, 2015b). The inclining tariff block structure is essentially a built- in conservation tool to "deter unnecessarily high water use... and encourage water conservation." (City of Cape Town, 2015b). In December 2015, dam levels in the City of Cape Town were at 61% of their storage capacity (as compared to 89% and 97% in 2014 and 2013, respectively). While the City always imposes Level 1 water restrictions (to encourage a 10% water savings), in December 2015 the City approved Level 2 water restrictions to be implemented from 1 January 2016. These include tighter restrictions around water usage (for example, irrigation to take place on certain days and between certain hours) as well as a tariff increase (City of Cape Town, 2015a). In this setting, this experiment provides a test of the ability of behavioural messages to encourage water conservation in times of extreme water scarcity.

In collaboration with the City, the behavioural messages were mailed to households as inserts with their monthly municipal bills. The messages were printed on blue paper to make them distinctive from the bill itself. Bills are delivered to households in twenty batches throughout the month. There exists currently six methods for payment: online, over the counter at any Absa bank or common retail stores (Spar, Kwikpay, Pick 'n Pay, Woolworths, Shoprite, Checkers U-Save, and Lewis stores), ATM and electronic funds transfer (EFT) payments, postal payments to the City of Cape Town, and debit order payment.

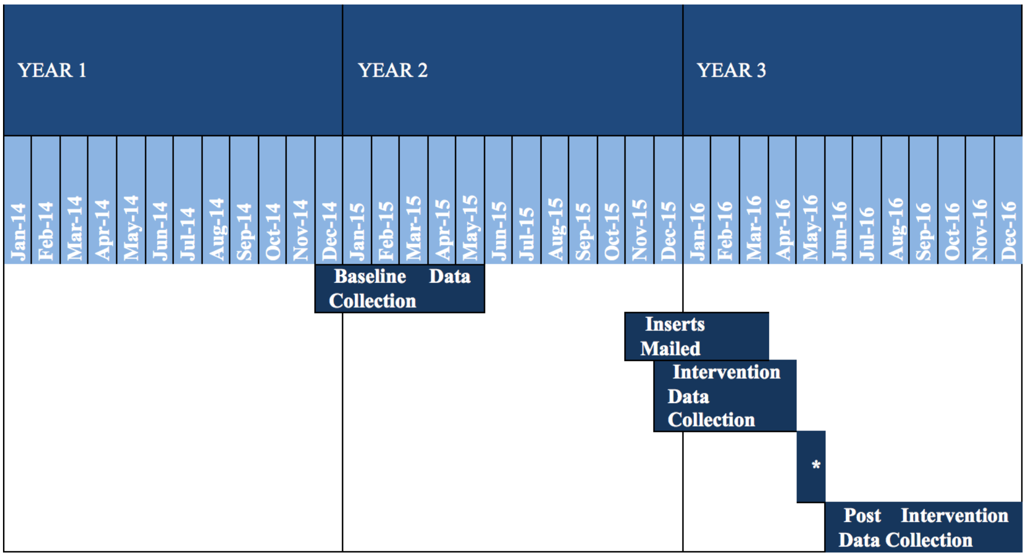
The initiative was launched in November 2015. Households were continually mailed the inserts on a monthly basis over a period of six months.

4.4.1 Timeline of roll-out

The first messages were delivered in November 2015, as inserts with the monthly municipal bill. Households receive the inserts on a monthly basis over a six -month period - from November to April. The strategy behind the 5 month intervention was two-fold: first we wanted to run the study over the summer months when water usage increases. Secondly the treatment originally was to run for six months. However, because the last insert (month 6) received for Social Recognition was whether the household achieved a 10% consumption savings, and not the normal message for month 1- 5, we cut analysis of the other treatments by one month in order to compare all with the same frequency and timing of inserts.

Households receiving message 5 and 6 who have been asked to reduce their consumption by 10%, were notified of how their household did in their May 2015 bill. Households receiving message 6 who managed to reduce their consumption by 10% over the study period and who thus qualify to have their information posted on the City's website, were given two months to notify the City that they do not want their information published. Thereafter, their names would be published on the City's website.

Figure 4.1: Timeline of Experiment



* = Winners for Social Recognition Treatment Announced

4.4.2 Sample

The total sample consists of approximately 335 000 households and includes all domestic water users living in free-standing houses with access to an uncontrolled water supply that is metered by a credit meter[10]. A credit meter is a physical device on the household's property which measures the amount of water supplied to home. By focusing on free-standing houses only, we are able to avoid households which are served by bulk water meters (as is the case with blocks of flats). Households are billed on a monthly basis with a physical bill mailed to the household address. The bill details the amount of water consumed in each tariff block, amount owed for the billing period, and total liability (see Figure D.2 in Appendix D for an example of a physical bill). We exclude households who receive an electronic bill ("Ebillers") from our sample. As the City has only recently initiated electronic billing (with currently less than 80 000 households in the registry) we are not concerned about the potential selection bias of not including Ebillers (who likely have higher income).

Power calculations were conducted using City of Cape Town consumption data

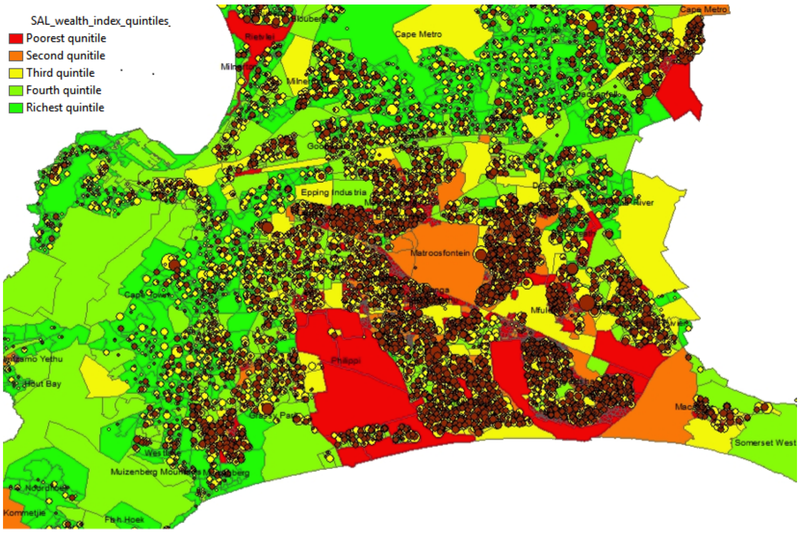
[10]Total sample for experiment is 412 478 which includes two additional treatments, which are variations of the financial and social recognition treatments, and analysed in separate papers. See Chapter 5 for analysis on social recognition treatments.

for the period October 2015 as this was the only data available at the time of randomisation. We matched municipal consumption data with the eligible sample. We removed those consuming below 6 kl per month as well as the 95th percentile to control for outliers. We then calculated mean consumption. We used two power calculations: one where we look at the mean consumption over the treatment period with an unbalanced panel and one where we use the balanced panel. With respect to the unbalanced panel, we are able to detect a 1.5% change in means per treatment with a minimum sample size of 18 579 per arm (with 80% power). With respect to the balanced panel (a sample of households whose consumption we observe in each month), we are able to detect a 1.5% change in means per treatment with a sample size of 14 104 households per arm (with 80% power). However, the analysis in this paper uses the months in the year prior for which our study was conducted in order to allow for seasonality effects as consumption increases in the summer months. Thus we run balance tests on the pre intervention period (see Table 4.6).

The sample of households is randomly allocated into either a control group (which does not receive a behavioural message) or one of seven treatment groups where each group receives one of the behavioural messages outlined in Section 4.3). All treatments receive the Tips treatment to control for availability of information on ways to change behaviour to conserve water. The sample was stratified on both suburb and tariff block before randomising. We chose to stratify on suburb as, due to the Apartheid legacy, income is heavily stratified by suburb lines to-date. See Figure 4.2 below, which shows the geographic dispersion of Treatment 1. Income is depicted in quintiles with a color gradient (red to green, with red equal to lowest income and green highest income).

We chose to also stratify on tariff block as a control for consumption. As mentioned, tariffs are priced according to six inclining consumption blocks. Households generally hover over two-three tariff blocks over the year. Thus while the suburbs control for income, tariff block controls for unobservables such as infrastructure quality, household size, and other determinants of household consumption. The sample

Figure 4.2: Geographic Dispersion of Treatment 1



Note: Treatment and control are depicted by the brown (treated) and yellow (control) circles.

sizes allocated to the control group as well as the treatment groups are reflected in Table 4.1. Note, we include the number of indigent households within each treatment: if the total household income is below a minimum threshold (<R300 000), households are able to apply for indigent status and receive government grants. Benefits include property rate reductions and the provision of free or subsidised basic services including water and refuse removal. We excluded the list of indigents for the randomisation of the graph and financial treatments (see Section 4.5.3), as these households do not pay for their utilities. This was to avoid misleading the households as the graph and financial savings insert have the billed amount indicated on the treatment insert. Indigents *were included* in all of the other treatments and randomised across control as well. However, as Table 4.1 indicates, there are still a number of indigents within the graph and financial treatments: at the time of randomisation, we were provided a list by the municipality of all registered indigents in the City of Cape Town. However, during the roll-out, we learned that this list was incomplete. Thus in our regressions, we denote the original list of indigents as 'Indigent A' and the additional indigents not in the original provided list as 'Indigent B'. We control for the indigent sample issue by only analysing heterogeneity effects, which allows us to compare non indigents across all treatments, as well as indigents

in all treatments except the graph and financial gain treatments (see Section 4.5.3 and Section 4.8 for details).

Table 4.1: Treatment allocation for November 2015 inserts

Treatment	Treatment allocation	No. of Indigents within allocation
Control	48 206	18 485
Tips	49 928	18 942
Graph	34 000	3 609
Financial Gain	33 687	3 593
Social norm	40 001	17 895
Intrinsic motivation	40 058	17 953
Social recognition	44 174	18 348
Public good	44 421	18 805
Total	**334 475**	**334 475**

The numbers in Table 4.1 reflect the total numbers allocated to each treatment. However, in a given month, households with estimated meter readings do not receive a message (so as not to give households inaccurate information) as well as households with billing periods greater than 35 days (which is usually indicative of a billing reversal or problematic bill). Finally, so as not to put low-income households in a vulnerable state, only households consuming in excess of the six kiloliter free monthly allocation receive a message.

4.5 Summary statistics

This section provides some summary statistics of the households allocated to one of the seven treatment arms.

4.5.1 Initial treatment allocation: November 2015

Table 4.1 indicates the number of households allocated to the control group and each of the seven treatment groups in the month of November. As previously discussed, not all households will receive an insert in a particular month. Specifically, a household will not receive an insert if:

- They are in tariff block 1

- Their bill is an estimated reading
- Their billing period is 35 days or more
- Their bill has been referred back to the City ("Referrals")

Table 4.2 reflects the number of households, per treatment, whose consumption falls into tariff block 1, who received estimated readings and/or whose billing period was greater than 35 days. As described, these households did not receive an insert in November.

Table 4.2: Summary statistics of those who did not receive an insert: November 2015

Treatment	Tariff block 1	Estimates	Billing period >35 days
Control	1 929	5 290	1 927
Tips	1 825	5 378	1 967
Graph	990	3 029	1 357
Financial Gain	1 010	2 964	1 178
Social norm	1 594	4 479	1 658
Intrinsic motivation	1 646	4 493	1 648
Social recognition	1 810	4 973	1 754
Public good	1 794	5 069	1 813
Total	**12 598**	**35 675**	**13 302**

Against all these conditions, Table 4.3 denotes the number of households that actually received an insert in the month of November (285 471 households).

Table 4.3: Number of households who received an insert in November 2015

Treatment/message group	Inserts Mailed
Control	48 206
Tips	41 312
Graph	28 771
Financial Gain	28 669
Social norm	32 769
Intrinsic motivation	32 837
Social recognition	29 158
Public good	26 907
Total	**268 629**

Notes: These numbers reflect the November attrition detailed in Table 4.2.

4.5.2 Final changes to treatment allocation

In the intrinsic motivation and social recognition treatments, households are asked to reduce their consumption by 10% over a six-month period which was in line with the public awareness campaigns the City ran simultaneous to our study. Households receive an initial announcement message which notes that "as you used X kl this month, you need to keep your monthly consumption around Y kl." The consumption value (X kl) is derived from the current bill. Thereafter, this consumption value remained unchanged and households are reminded each month that their target level of consumption is X kl.

However, there were a number of households who did not receive the social recognition inserts in November because of being in tariff block 1, receiving an estimated reading or having a reading period of greater than 35 days. As they did not receive the initial insert in November, we dropped them from the treatment entirely as the household would otherwise be one month behind the six-month framing of the mailer. We reallocated these households equally across the remaining treatments (control, tips, graph, gain, loss, social norm and public good) via the randomisation method. The updated treatment allocation is reflected in 4.4.

Table 4.4: Treatment re-allocation for December 2015 - April 2016

Treatment	Treatment allocation	Amt. of indigents in allocation
Control	51 113	20 471
Tips	52 833	20 925
Graph	36 888	5 222
Gain	36 584	5 311
Social norm	33 043	14 413
Intrinsic motivation	32 724	14 324
Social recognition	38 557	14 638
Public good	47 316	20 822
Total	**329 058**	**116 126**

Notes: Due to the re-allocation in December after November's attrition (see description above), the sample size in each treatment was adjusted. This remained the final sample size in each treatment for the continuation of the experiment through April 2016.

4.5.3 Randomisation

We test whether the finalised treatment and control groups are balanced in terms of several demographic characteristics, namely, monthly consumption, daily average consumption, number of billing days (over the month), property value, and tariff block. Table 4.5 shows the descriptive mean and standard deviation for all treatments and control, as well as the p-value from the t-tests of equal means whereby the null hypothesis is equal means. As noted, we excluded the list of indigents for the randomisation of the graph and financial treatments, as these households do not pay for their utilities. This was to avoid misleading the households as the graph and financial savings insert have the billed amount indicated on the treatment insert. Indigents *were* included in all of the other treatments and importantly, randomised across control as well. To control for this issue, we use the full pooled sample in the average treatment effect (ATE) regressions and interact the treatments with the indigent households (referred to as 'Indigents A' in the tables). This allows us to compare the ATE of non-indigents across all treatments, and also compare the ATE of the indigent households across all treatments except graph and financial gain (as they were excluded from the randomisation of these treatments for reasons explained above). See regressions in Section 4.8 for further details.

Table 4.5: Demographic characteristics by treatment group for October 2015: Full sample

		Treatment mean	Treatment s.d.	Control mean	Control s.d.	T-test of means (p-value)	Observations
	Tips	21.77	39.69	22.55	104.73	0.121	49 928
	Graph	22.14	33.68	22.55	104.73	0.487	34 000
	Gain	22.37	43.15	22.55	104.73	0.761	33 687
Consumption (kl)	Social Norm	20.89	42.72	22.55	104.73	0.006	40 001
	Intrinsic Motivation	22.11	108.12	22.55	104.73	0.559	40 058
	SR	22.46	45.68	22.55	104.73	0.87	44 174
	Public Good	21.33	55.84	22.55	104.73	0.038	44 421
	Tips	0.67	0.92	0.67	2.3	0.952	49 928
	Graph	0.71	1.22	0.67	2.3	0.001	34 000
	Gain	0.7	0.97	0.67	2.3	0.027	33 687
Daily average (kl)	Social Norm	0.64	0.73	0.67	2.3	0.048	40 001
	Intrinsic Motivation	0.65	0.96	0.67	2.3	0.336	40 058
	Social Recognition	0.65	1.07	0.67	2.3	0.271	44 174
	Public Good	0.65	0.89	0.67	2.3	0.127	44 421
	Tips	741 097.72	1 111 771	727 149.37	1 073 219	0.051	49 928
	Graph	1 034 363.4	1 291 790.8	727 149.37	1 073 219	0	34 000
	Gain	1 027 314	1 252 492.8	727 149.37	1 073 219	0	33 687
Property Value ($R)	Social Norm	681 454.17	995 674.83	727 149.37	1 073 219	0	40 001
	Intrinsic Motivation	679 334.14	1 000 515.4	727 149.37	1 073 219	0	40 058
	Social Recognition	718 531.62	1 091 643.2	727 149.37	1 073 219	0.262	44 174
	Public Good	714 324.75	1 110 165.9	727 149.37	1 073 219	0.092	44 421
	Tips	32.96	24.26	33.26	26.24	0.06	49 928
	Graph	32.23	21.28	33.26	26.24	0	34 000
	Gain	32.5	22.57	33.26	26.24	0	33 687
Billing period (days)	Social Norm	32.46	22.24	33.26	26.24	0	40 001
	Intrinsic Motivation	32.73	24.32	33.26	26.24	0.003	40 058
	Social Recognition	32.7	23.56	33.26	26.24	0.001	44 174
	Public Good	32.79	23.45	33.26	26.24	0.006	44 421
	Tips	3.17	1.03	3.15	1.01	0.001	49 928
	Graph	3.28	1.02	3.15	1.01	0	34 000
	Gain	3.27	1.01	3.15	1.01	0.016	33 687
Tariff block	Social Norm	3.15	1.01	3.15	1.01	0.761	40 001
	Intrinsic Motivation	3.16	1.01	3.15	1.01	0.406	40 058
	Social Recognition	3.17	1	3.15	1.01	0.034	44 174
	Public Good	3.15	1.02	3.15	1.01	0.416	44 421

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As noted, we stratified the sample on suburb and tariff block. Thus we use suburb and tariff block fixed effects in all regressions. Furthermore, we control for property value and separately, billing period using month dummies as billing period is a seasonal trend.

4.6 Pre intervention analysis

While we randomised the sample based upon October 2015 data as this was the only data available at the time, we later received access to historical consumption data. In order to control for seasonality, we chose to use December 2014 to April 2015 as the pre intervention baseline period in our analysis. Figure 4.3 graphically depicts water use trends in the pre intervention period. From Figure 4.3 it is evident that there is a seasonal component to water usage: specifically, average monthly consumption is higher in the warmer summer months. However, this seasonal trend is common across the groups. All groups experience a spike in average billing days around January/February (see Figure 4.4). The increase over the warmer summer months in January and February come from both an absolute increase in consumption due to higher temperatures and more time spent at home during the holidays but also an increase in billing period as the City of Cape Town works on a skeleton staff during the holiday season. Given the data depicted in these graphs, we need to control for seasonality effects. We also control for month-fixed effects in all of our models due to the increase in consumption in January. The graph also shows similar trends in treatment and control groups, which supports the parallel trends assumption for a difference-in-difference estimation.

Figure 4.3: Mean monthly consumption by Treatment group

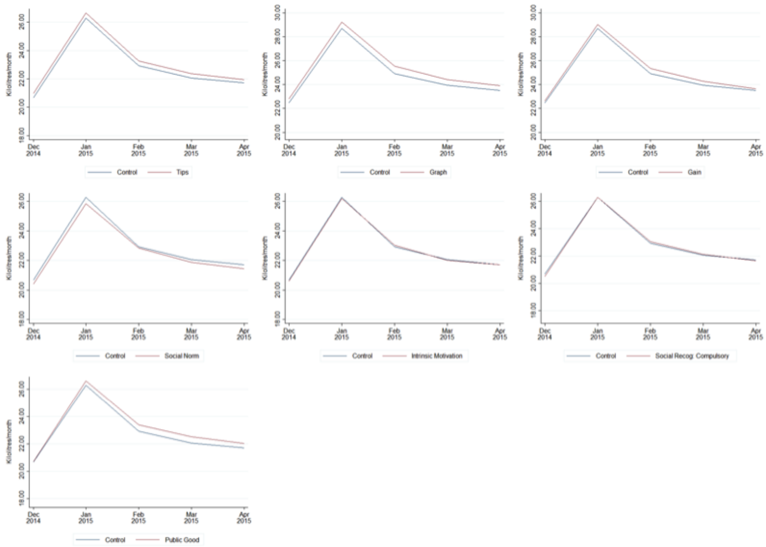


Figure 4.4: Mean billing days by Treatment group

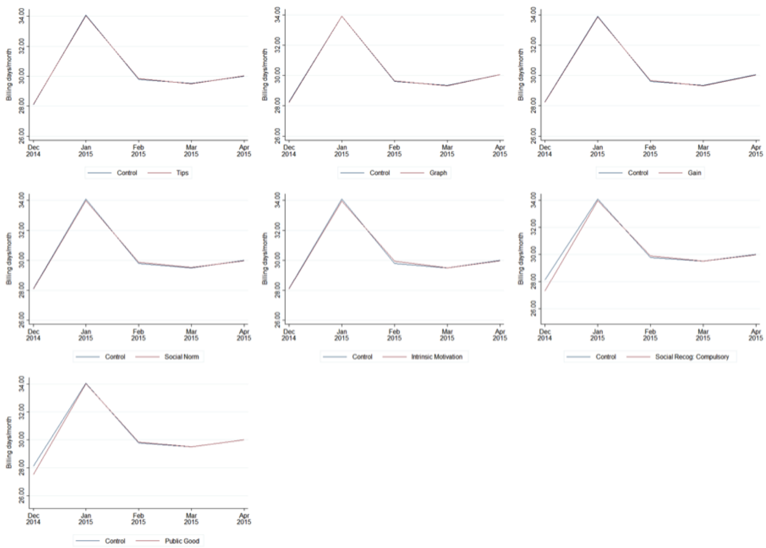


Table 4.6 tests if the sample is balanced across treatment and control groups for the pre intervention period. The estimates are based on a regression of the outcome variable/characteristic as the dependent variable and dummy variables for the treatment groups (omitting the control group) as explanatory variables. Following Bruhn and McKenzie (2009), we control for stratification by including tariff block and suburb dummy variables in the regressions.

Table 4.6: Balance test regressions for the pre intervention period of December 2014 to April 2015

	I Means	II Monthly consumption (kl)	III Daily average (kl)	IV Property Value ($R)	V Billing period (days)
Tips	20.86	0.038	-0.002	-2652.741	0.003
		0.081	0.003	3627.477	0.007
Graph	22.41	0.074	-0.002	-1336.874	-0.005
		0.086	0.004	4387.197	0.008
Gain	22.19	0.004	0.00	-6488.949	-0.014
		0.085	0.004	4027.763	0.009
Social norm	20.42	0.037	0.00	-1775.921	-0.016**
		0.080	0.004	3261.424	0.007
Intrinsic motivation	20.59	0.174**	0.004	367.503	-0.002
		0.084	0.004	3705.814	0.007
Social Recognition	20.65	0.127	0.00	94.626	0.108***
		0.085	0.004	4052.323	0.028
Public Good	21.00	0.086	0.001	-6507.887	0.084***
		0.077	0.003	4062.262	0.023
Constant		15.722***	0.529***	804726.811***	30.383***
		0.177	0.006	7200.799	0.013
Indigent status		Yes	Yes	Yes	Yes
TB fixed effects		Yes	Yes	Yes	Yes
Suburb fixed effects		Yes	Yes	Yes	Yes
Observations	1 186 621	1 186 621	1 186 621	1 126 282	1 186 621
Treated	1 044 622	1 044 622	1 044 622	991 028	1 044 622
Treat1	144 622	144 622	144 622	137 537	144 622
Treat2	105 364	105 364	105 364	98 813	105 364
Treat3	104 183	104 183	104 183	97 804	104 183
Treat4	108 334	108 334	108 334	103 384	108 334
Treat5	107 981	107 981	107 981	103 323	107 981
Treat6	122 610	122 610	122 610	116 594	122 610
Treat7	126 378	126 378	126 378	120 301	126 378
Control	141 999	141 999	141 999	135 254	141 999
Fpvalue	0	0.492	0.911	0.131	0
R-squared	0.019	0.411	0.211	0.719	0.019

Notes: Regressions include tariff block and suburb fixed effects. Standard errors are clustered at the suburb level and are presented below the coefficient. Regressions are run for the pre-intervention period December 2014 - April 2015.

Although the randomisation was conducted on October 2015 data and not pre intervention data from December 2014-April 2015, the treatment and control groups are still balanced. Billing period is an exception, and we control for billing period with month-fixed effects as the billing period increases due to seasonal staff adjustments during the holiday period. Thus households receive a longer period bill in January and February after the holidays which often includes December consumption. We also control for billing period with a frequency variable which indicates the cumulative number of times the household appears in the sample (due to differences in billing period days or reasons listed in Section 4.5).

4.6.1 Pre Intervention trend analysis

One of the key identifying assumptions of the difference-in-difference model is that water usage trends would be the same in the control and treatment groups in the absence of the treatments and that the intervention induces the deviation from this common trend (Angrist and Pischke, 2008). While Figure 4.3 and Figure 4.4 suggests that treated and control households have comparable pre intervention trends, following Abramitzky and Lavy (2014), we use pre intervention data from December 2014 to April 2015 to determine whether the treatment and control groups have differential time trends with respect to water usage. Means are reported in Table 4.7. The estimated results are reflected in Table 4.8. Panel A reflects the results of a constant linear time trend model which allows for an interaction of the trend with the treatment indicator, while, in Panel B, the linear time trend variable is replaced by a series of month dummies as well as an interaction of the treatment indicator with each of these time dummies (Abramitzky and Lavy, 2014). While the results from both models confirm the presence of a time trend with respect to water usage, in general this trend is identical for treated and non-treated households. The results in Panel A suggest that, on average, water consumption decreases by approximately 180 liters per month. However, as evident by the interaction term (Treatment X Trend), this trend does not differ significantly for treatment and control groups for most of the treatments. The estimates in the dummies model (Panel B) however shows the heterogeneity across months. As trend does seem to differ across some of the treatment and control groups, we control for trend in the regressions.

Table 4.7: Pre Intervention Means

	Baseline means (kl consumption)
Income - 1st quintile	18.23
Income - 2nd quintile	18.44
Income - 3rd quintile	20.12
Income - 4th quintile	24.10
Income - 5th quintile	34.72
Long run baseline mean (Dec 2014 - April 2015)	23.37
Short run baseline mean (Dec 2014)	21.26

Table 4.8: Differences in the time trend of water usage in treated and control households during pre treatment months (November to April 2015)

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VII Monthly consumption (kl)
	Tips	Graph	Gain	Social Norm	Intrinsic Motivation	Social Recognition	Public Good
Panel A							
Pre-intervention trend	-0.182***	-0.178***	-0.177***	-0.182***	-0.177***	-0.180***	-0.179***
	0.037	0.037	0.037	0.037	0.037	0.037	0.037
Treatment	0.116	0.266*	0.157	-0.047	0.136	0.307**	0.224*
	0.109	0.14	0.151	0.112	0.124	0.135	0.125
Treat x Pre-trend	-0.028	-0.058*	-0.043	0.03	0.012	-0.055*	-0.039
	0.023	0.031	0.034	0.026	0.026	0.03	0.03
Panel B							
Treat	-0.071	-0.185*	-0.249**	0.068	0.181*	0.482***	0.362***
	0.094	0.11	0.11	0.097	0.1	0.103	0.099
14-Dec	-1.121***	-1.137***	-1.142***	-1.119***	-1.138***	-1.133***	-1.135***
	0.177	0.178	0.178	0.177	0.177	0.179	0.178
15-Jan	4.714***	4.710***	4.705***	4.712***	4.700***	4.709***	4.710***
	0.25	0.251	0.251	0.249	0.25	0.248	0.249
15-Feb	1.053***	1.043***	1.040***	1.053***	1.048***	1.056***	1.045***
	0.262	0.261	0.261	0.262	0.261	0.262	0.261
15-Mar	0.374***	0.371***	0.364***	0.376***	0.371***	0.366***	0.365***
	0.127	0.127	0.127	0.127	0.128	0.128	0.127
15-Apr	0	0	0	0	0	0	0
	.	.	.	.	.	.	.
DEC2014 x treat	0.128	0.008	-0.002	-0.062	0.105	0.178	-0.2
	0.087	0.126	0.135	0.104	-0.132	0.144	0.175
JAN2015 x treat	0.119	0.794***	0.731***	-0.195	0.13	0.249	0.301
	0.125	0.185	0.187	0.131	0.097	-1.047***	0.229
FEB2015 x treat	0.156*	0.438***	0.461***	0.121	0.114	0.219	-0.954***
	0.094	0.152	0.166	0.102	-0.017	-0.663***	0.198
MAR2015 x treat	0.1	0.179*	0.226**	0.012	0.095	0.14	-0.452***
	0.082	0.1	0.105	0.09	0	0	0.127
APR2015 x treat	0	0	0	0	.	.	0
	.	.	.	.	.	.	.
Constant	14.671***	14.738***	14.702***	14.739***	14.691***	14.646***	14.829***
	0.235	0.216	0.222	0.25	0.249	0.229	0.258

Indigent status	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TB fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Suburb fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	286 621	247 363	246 182	250 333	249 980	264 609	268 377
Treated	144 622	105 364	104 183	108 334	107 981	122 610	126 378
Control	141 999	141 999	141 999	141 999	141 999	141 999	141 999
R-squared	0.42	0.429	0.424	0.417	0.418	0.423	0.425

Notes: Regressions include tariff block and suburb fixed effects. Standard errors are clustered at the suburb level and are presented below the coefficient.

Overall the models indicate that treatment and control households followed the same trend with respect to water usage in the year preceding the intervention (December 2014-April 2015).

4.7 Identification Strategy

The estimate of interest is the "treatment-on-the-treated" (TOT), which estimates the impact of the program on those who were sent an insert in their monthly municipal bill and who received the insert in that month compared to those in the control who did not receive an insert. This is in contrast to the "intention-to-treat" estimate (ITT), which is a straight comparison of those who were allocated the treatment versus the control who did not receive an insert. The difference between TOT and ITT is due to billing issues as described in the section above. If the treatment, T, is a behavioural nudge to reduce water consumption in household i, we want to estimate the causal effect of T on the water consumption (daily average and monthly total) of household i in the City of Cape Town. In order to understand the causal effect, we need to measure the average water consumption in household i in time $t = 1$ randomly chosen from the population in the City of Cape Town, if we provided a behavioural nudge via insert in their monthly municipal bill, $T_i = 1$, as opposed to not providing a behavioural nudge via insert in their monthly municipal bill, $T_i = 0$.

$$E[\bar{Y}_{i,t=1}^{T=1}] - E[\bar{Y}_{i,t=1}^{T=0}] \tag{4.1}$$

However, it is not possible to study the counterfactual, as we cannot observe two states of the household simultaneously. A simple before-after study would only show the overall outcome on the household, not controlling for factors outside of the experiment that could have contributed causally to the current level of consumption. Thus we use a randomised controlled trial whereby every free-standing domestic household in the City of Cape Town had an equal probability of receiving an insert.

The outcomes of interest in our experiment are i) total monthly consumption and ii) average daily, and iii) relative consumption (compared to relative change from the same month in the year prior). To determine whether the intervention influenced water consumption, we regress post-intervention water consumption on treatment and control for baseline water consumption (Datta et al., 2015; Bhanot, 2015). The econometric specification is as follows:

$$Y_i = \beta_0 + \beta_m Treatment_m + \epsilon_i \tag{4.2}$$

Where Y_i is water usage by household i measured in kilolitres per month in post-intervention period and $Treatment_m$ are dummy variables for the seven treatments (with the control group as the reference case). We also replicate the regressions including a number of control variables. Once again, standard errors are clustered at the suburb level. The pooled regressions for all three outcomes are included in Appendix D. See Tables D.3, D.4, D.5. We find the financial gains, intrinsic motivation, social recognition and appeals to the public good equally reduce consumption by approximately 170 litres on average each month. When using relative consumption as the outcome variable, we see all treatments reduce consumption significantly approximately 1-2% over the month with the exception of social norms where we see no significant effects. However, these regressions do not control for trend over the pre and post period.

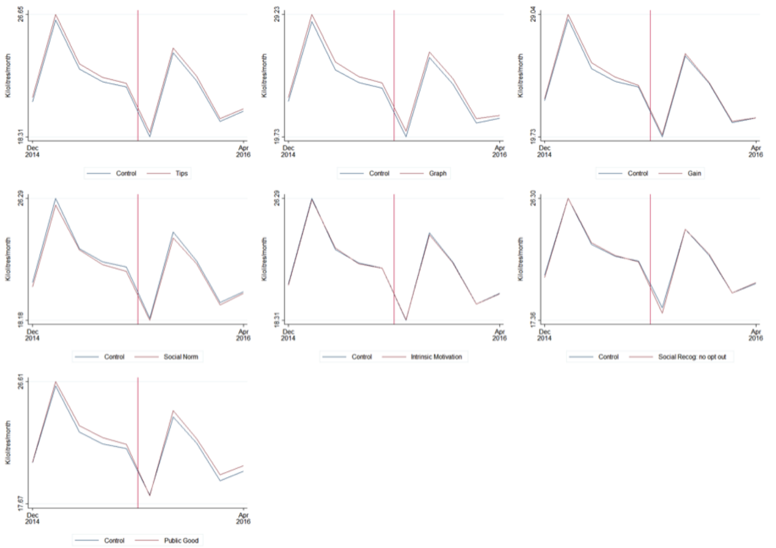
In order to compare the effect of our treatments on water consumption in household i and control for trend, we use difference-in-difference methods as our main method. Difference-in-differences compares the changes in outcomes over time between treated households, $T = 1$, and control households, where $T = 0$. Difference-in-differences compares the before-and-after outcomes for the households that received the insert (the first difference) and the before-and-after outcomes for the households that did not receive the insert but was exposed to the same set of economic and environmental conditions (Gertler et al., 2011). Then the difference between the difference in outcomes for the treated and the comparison is calculated. This controls for factors that are constant over time as well as factors that are time-varying

(Gertler et al., 2011).

$$E(Y) = [E[\bar{Y}_1^{T=1}] - E[\bar{Y}_0^{T=1}]] - [E[\bar{Y}_1^{T=0}] - E[\bar{Y}_0^{T=0}]] \tag{4.3}$$

Difference-in-differences assumes time trends in the absence of the intervention are the same in both groups. However we control for differential time trends as a robustness check. As we can see in Figure 4.5, there is a significant time trend difference in pre intervention versus post-intervention.

Figure 4.5: Mean consumption, Dec 2014 - April 2015 and Dec 2015 - April 2016, by Treatment



Our reduced form expression for the causal effect of a reduction in water consumption due to receiving an insert is estimated by the below regression:

$$E(Y) = \alpha + \beta_1 D_i^{T=1,0} + \beta_2 D^{After} + \beta_3 D_i^{T=1,0} \times D^{After} + \beta_4 Trend + \beta_5 X_i' + \epsilon_i \tag{4.4}$$

where $D^{T=1,0}$ is the observation if the household is in a treatment group, either before or after the treatment is received. $D^{After} = 1$ is the observation if the household is in either group after the treated group has received the treatment. β_1 captures the underlying differences between the treatment and control groups, β_2 captures the underlying differences between the two time periods, and β_3 captures the effect of the treatment on the treatment compared to the control group after the intervention. β_4 controls for the effect of trend.

X_i' is a vector for controls. As stated, our main controls are informed from the balance and pre intervention trend regressions, which include property values, baseline tariff block, month and suburb fixed effects and indigent status. In addition, we also include a control if the household was a "late receiver", a status given to households billed later in the period month. We also control for the amount of times the household appears in the panel (frequency), and the following two separately: the billed amount, and the tariff rate billed at, in the month prior. The reason for the latter controls is to control for the effect of the previous bill's amount/tariff rate on the current household consumption. For example, if a household was charged at a higher rate in November, either due to an increase in tariff or due to higher consumption/presence of a leak, this might reflect a change in behaviour in December.

We then estimate heterogeneous treatment effects by interacting the treatment with indigent households. Indigent status in the City of Cape Town is provided to households who struggle to pay for public utilities. Given the household has a property value under a certain threshold(<R300 000), or are considered eligible after a means assessment, the household qualifies for subsidised rates or service free-of-charge. β_6 represents the effect of the treatment on indigent households.

$$Y_i = \alpha + \beta_1 D_i^{T=1,0} + \beta_2 D^{After} + \beta_3 D_i^{T=1,0} \times D^{After} + \beta_4 Trend +$$
$$\beta_5 Indigent_i + \beta_6 Indigent_i \times D_i^{T=1,0} + \beta_7 Indigent_i \times D_i^{T=1,0} + \beta_2 D^{After} + \beta_8 X_i' + \epsilon_i \tag{4.5}$$

All standard errors are clustered at the suburb level. We use a fixed effects model to control for the unobserved heterogeneity across treatment and control that does not vary over time. We include robustness checks for the difference-in-difference regressions for models without fixed effects and without trend in Appendix D.6 (page 272) and D.7 (page 274). Short-run (once-off) regressions are also included in

D.1 (Page 261).

4.8 Experimental results with DiD

The DiD estimates for the average treatment effects for the panel (December 2015 - April 2016) are reported in Table 4.9. As the indigent households were not assigned to the graph and financial mailers, we are only able to analyze the full sample when including indigent interaction effects. This allows us to interpret the coefficients on the non-indigents for the graph and financial gains treatments (columns I-III in Table 4.9). All regressions show a significant reduction in consumption due to graph, financial gains, social recognition and public good.

In the pooled results, all treatments have a significant effect on the non-indigents, reducing consumption between 200-530 litres/month. However social recognition has the largest impact on non-indigents (500 litres, columns I-III in Table 4.9). Conversely, we see that the indigents reacted negatively to all social incentives compared to the indigents in the control group: they increased their consumption if given the social norms, intrinsic motivation, social recognition, or public good mailer.

Social approval is a key finding from our study: publicly faming has large impacts but must be used with caution. Publicly recognising non-indigent citizens for their water savings efforts had a significant effect on reducing consumption over and above conventional tariff hikes and water restrictions. Stating in an insert that the City will publicly recognise water savers on the City's website had an average reduction of 520 litres for non-indigents (equivalent to a 2.2% decrease in consumption from the baseline mean). Yet, indigents respond to the treatment by *increasing* their consumption by 550 litres. See Chapter 5 for a deeper analysis on this issue as it is outside the scope of this paper.

Appeals to the public good resulted in an average decrease of 300 litres, equivalent to a 1.3% reduction in consumption (columns V in Table 4.9).Social norms - the incentive promoted by Allcott (2011); Ferraro et al. (2011); Ayres (2010) - resulted in an average *increase* of 550 litres for indigents (Table 4.9), equivalent to a 2.4% increase in consumption. Conversely, social norms *reduces* consumption by approximately 300 litres in the non-indigent sample, which is equivalent to a 1.3% decrease in consumption (columns I-III in Table 4.9). Again we see that a social incentive - social norms in this case - increases consumption in the indigent sub sample (by approximately 500 litres). This is likely due to the rebound effect: they were consuming below the average and rebound to the reference point. However, local averages were computed for the household's suburb. As income corresponds to suburb lines in Cape Town, we would assume that their neighbour is comparable in income, and by extension, consumption. We leave this for further research.

The overall results highlight the relative successes of behavioural messaging in reducing consumption over and above the tariff increases and water restrictions (note, we could not separate the effect of the tariff increases during this time period as it was nearly perfectly collinear with the *Post* variable). In the following section we conduct heterogeneity analysis on income quintiles excluding CoCT indigents in Table 4.10[11].

Using our main model - income quintile regressions[12] - we observe that lower income households respond only to the financial gains mailers, whereas higher income households respond only to the social incentives. We calculate the percentage reduction of consumption from each treatment using the pre intervention mean values in Table 4.7.

The poorest households reduce their water consumption most when provided the financial incentive. The financial savings mailer had a significant and negative

[11]Table D.2 in the Appendix on page 263 shows the ATE in the sample excluding CoCT indigents. In the average treatment effects excluding CoCT indigents, where we see significant effects on all treatments and social recognition having the largest impact on water savings, reducing consumption by approximately 380 litres/month (column V in Table D.2). The main difference between the ATE in the full sample in Table 4.9 versus the sample excluding CoCT indigents, Table D.2, is that the effects on the financial treatments are muted in the Table D.2 excluding CoCT indigents. This is due to the sample having on average higher income than the main sample, as we find results differ significantly depending on which income quintile the household sits (please see income quintile analysis below to see how strongly different income groups respond to different incentives).

[12]excluding CoCT indigents in order to compare across treatments. We chose to use the full model in the ATE to balance the income, however when conducting quintile regressions we are able to analyse the sample excluding indigent households ('Indigents A') in order to compare the graph and financial treatments across a balanced sample within each income quintile.

impact on consumption: 600 litres (column 2 of Table 4.10) equivalent to a 3.3% decrease for the lowest income quintile. The impact decreases to approximately 260 liters (column 4 of Table 4.10) in the third quintile, and then the effect goes away in higher income quintiles[13].

Wealthier households (those in the fourth and fifth income quintiles) do not respond to the financial gain mailer: we observe no significant effects on consumption for these households who are likely to be less responsive to price signals given the relatively smaller share of their budget allocated to water.

Rather, the higher income groups respond only to the social incentives: social recognition, social norms, appeals to their intrinsic motivation, and appeals to the public good. Social norm and intrinsic motivation mailers have an equal effect, reducing consumption by 290 litres in the third quintile (column 3 in Table 4.10) and 360 liters in the fourth quintile (column 5 in Table 4.10). This is equivalent to an effect size of 1.5% for fourth income quintile.

Appeals to the household's intrinsic motivation reduces consumption by 315 litres (column 5) and 500 litres (column 7), respectively, in the 4th and 5th quintile, equivalent to a 2.1% effect for the wealthiest households.

The highest income households are also responsive to the public good framing, reducing consumption by 480 liters per month (2% of consumption). Relative to the previous income group, it appears that responsiveness to both intrinsic motivations and public good appeals increase with income.

Finally, social recognition has the highest impact in the highest income quintile, reducing water usage by 900 liters per month (2.6% of consumption). We interpret these results in the conclusion.

[13]Note, we cannot analyse the first income quintile in the sample excluding CoCT indigents as it is too small of a sample.

Table 4.9: Long Run Analysis (Dec 2015 - April 2015): Difference in difference model using fixed effects with trend

	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)
	I	II	III	IV
Tips x Post	-0.202**	-0.210***	-0.201***	-0.191**
	0.08	0.08	0.072	0.083
Graph x Post	-0.239***	-0.234***	-0.242***	-0.231***
	0.081	0.081	0.073	0.085
Financial gains x Post	-0.316***	-0.323***	-0.299***	-0.283***
	0.076	0.078	0.07	0.077
Social norm x Post	-0.305***	-0.314***	-0.288***	-0.286***
	0.09	0.09	0.08	0.09
Intrinsic motivation x Post	-0.319***	-0.317***	-0.308***	-0.294***
	0.086	0.088	0.08	0.087
Social recognition x Post	-0.503***	-0.516***	-0.521***	-0.498***
	0.096	0.097	0.09	0.099
Public Good x Post	-0.286***	-0.294***	-0.315***	-0.270***
	0.085	0.086	0.077	0.088
Trend	-0.269***	-0.261***	-0.283***	-0.279***
	0.015	0.014	0.014	0.016
Indigent Status	1.412***	1.434***	1.425***	0.941**
	0.389	0.389	0.388	0.369
Frequency (-1)		-0.022		
		0.037		
Billed amount (-1)			0.005***	
			0	
Tariff rate (-1)				-0.053***
				0.003
Post x indigent	2.079***	2.059***	2.020***	2.187***
	0.235	0.238	0.224	0.268
Tips x indigent	0.142	0.14	0.197	0.077
	0.249	0.237	0.228	0.269
Graph x indigent	-	-	-	-
	-	-	-	-
Financial gains x indigent	-	-	-	-
	-	-	-	-
Social norm x indigent	-0.506	-0.406	-0.367	-0.365
	0.323	0.324	0.307	0.336
Intrinsic motivation x indigent	-0.481	-0.507*	-0.413	-0.341
	0.295	0.298	0.279	0.323
Social recognition x indigent	-0.534*	-0.541*	-0.435	-0.607*
	0.301	0.3	0.279	0.32
Public Good x indigent	-0.585**	-0.574**	-0.508**	-0.555**
	0.268	0.276	0.256	0.267
Tips x indigent x Post	0.235	0.259	0.23	0.280*
	0.158	0.162	0.143	0.156
Graph x indigent x Post	-	-	-	-
	-	-	-	-
Financial gains x indigent x Post	-	-	-	-
	-	-	-	-
Social norm x indigent x Post	0.566***	0.551***	0.479***	0.563***
	0.155	0.159	0.139	0.158
Intrinsic motivation x indigent x Post	0.243*	0.276*	0.253*	0.258*
	0.142	0.146	0.132	0.15
Social recognition x indigent x Post	0.567***	0.585***	0.540***	0.608***
	0.159	0.165	0.15	0.163
Public Good x indigent x Post	0.261*	0.251	0.231*	0.307**
	0.155	0.157	0.138	0.156
Constant	27.642***	27.632***	26.652***	28.730***
	0.316	0.296	0.349	0.298
Observations	2074219	2042709	2042709	1821003
Treated	1769214	1742722	1742722	1553673
Control	305005	299987	299987	267330
Clusters	672	672	672	672

Fpvalue	0	0	0	0
R-squared	0.078	0.079	0.097	0.092

Notes: Standard errors are clustered at the suburb level and are presented below the coefficient. Pre-intervention period: December 2014 - January 2015. Post-intervention period: December 2015 - January 2016. Treated category include all treatments with at most five months of observations. We cannot analyse coefficients on the indigent interactions for tariff graph and financial gains mailer given they were not provided the treatment.

Table 4.10: Income Quintile Analysis excluding CoCT Indigents: Difference in Difference model using fixed effects with trend

	2nd Quintile		**3rd Quintile**		**4th Quintile**		**5th Quintile**
	1	2	1	2	1	2	1
	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)
Tips x Post	-0.238	-0.204	-0.177	-0.183	-0.079	-0.07	-0.22
	0.178	0.182	0.13	0.129	0.151	0.153	0.183
Graph x Post	-0.022	-0.014	-0.208	-0.205	-0.084	-0.082	-0.233
	0.193	0.212	0.134	0.133	0.166	0.166	0.169
Financial gains x Post	-0.394**	-0.596***	-0.244*	-0.261**	-0.178	-0.173	-0.1
	0.191	0.222	0.129	0.128	0.146	0.146	0.184
Social norm x Post	-0.222	-0.239	-0.287*	-0.277*	-0.358**	-0.350**	-0.308
	0.187	0.226	0.154	0.149	0.155	0.154	0.212
Intrinsic motivation x Post	-0.3	-0.294	-0.035	-0.05	-0.314**	-0.304**	-0.498**
	0.225	0.265	0.136	0.136	0.151	0.152	0.199
Social recognition x Post	0.101	0.012	-0.266*	-0.281**	-0.208	-0.203	-0.895***
	0.221	0.228	0.14	0.14	0.161	0.163	0.221
Public Good x Post	0.071	0.123	-0.345**	-0.356**	-0.02	-0.015	-0.476**
	0.199	0.233	0.144	0.145	0.15	0.15	0.211
Tips x Indigent B x Post		-0.134		1.021		-8.655	
		0.47		2.255		5.257	
Graph x Indigent B x Post		-0.035		-2.774		-0.109	
		0.422		2.875		4.475	
Financial gains x Indigent B x Post		0.719		3.161		-5.529	
		0.497		2.194		5.148	
Social norm x Indigent B x Post		0.058		-3.17		-5.062	
		0.581		5.313		6.54	
Intrinsic motivation x Indigent B x Post		-0.036		3.729		-8.936	
		0.482		2.847		10.742	
Social recognition x Indigent B x Post		0.332		2.829		-3.909	
		0.462		2.833		4.842	
Public Good x Indigent B x Post		-0.196		1.451		-2.999	
		0.433		3.021		4.968	
Constant	4.243***	4.301***	5.181***	5.169***	8.933***	8.936***	14.490***
	0.367	0.36	0.354	0.354	0.567	0.568	0.508
Observations	199714	199714	377576	377576	403491	403491	397246
Treated	174606	174606	331304	331304	353927	353927	349255
Control	25108	25108	46272	46272	49564	49564	47991
Clusters	289	289	390	390	460	460	459

R-squared	0.218	0.219	0.244	0.244	0.249	0.249	0.269

Notes: We chose to use the full model in the ATE to balance the income, however when conducting quintile regressions we are able to analyse the sample excluding indigent households ('Indigents A') in order to compare the graph and financial treatments across a balanced sample within each income quintile. We did not have enough power to estimate the effects on the 1st income quintile when excluding indigents, as the majority of indigents sit in the 1st income quintile. In the other quintiles, we are able to measure heterogeneity effects of the 'Indigent B' group: recall during the intervention we learned the City provided us with an incomplete list of registered indigent households. Thus some indigents *did* receive the graph and financial gains treatment (labeled as 'Indigent B'): those who are indigents but were not on the master list (labeled as 'Indigent A') that we were provided before the roll-out of the intervention. Tariff block, suburb and month fixed effects included. Standard errors are clustered at the suburb level and are presented below the coefficient. Pre-intervention period: December 2014 - January 2015. Post-intervention period: December 2015 - January 2016. Treated category include all treatments with at most five months of observations.

4.9 Discussion and Conclusion

Social norms have been identified as the strongest incentive to promote proenvironment behaviour both in the energy and water context in the United States (Allcott, 2011; Ferraro et al., 2011; Ayres, 2010). We contribute to the literature by using a city-wide randomised control trial in the City of Cape Town, South Africa, to promote water conservation in the summer months when water consumption is higher, and at the time of a severe drought, in a population suffering from extreme income inequality. Following the contribution of Allcott (2011) and others, a sample of over 330 000 residential households in the City of Cape Town were sent monthly inserts with their municipal bill over a period of five months.

The broad objective of the study is to disentangle the channels through which people are incentivised to conserve in a developing country context beset by extreme inequality as well as drought. To do so, we disaggregate various elements within common social norm messages used in U.S. home energy and water reports (Allcott, 2011; Ferraro et al., 2011; Ayres, 2010) into individual treatments (tips, tariff graph, financial gains, social norms, and additionally test new treatments: appeals to intrinsic motivation, social recognition, appeals to the public good). We used randomisation methods when sampling to analyse causal impacts. To control for any issues with the randomisation as well as the observed decrease in consumption across all treatment and control from baseline, we use difference-in-difference methods and control for time trend and observable household characteristics. In order to compare all treatments, we only analyse indigent heterogeneity effects in order to control for our inability to analyse the impact of graph and financial gain mailers on the indigent households.

Surprisingly, when comparing the effect of each treatment on water consumption, the social norm message is *outperformed* by financial savings and social recognition mailers. Even more striking, we find heterogeneity in responsiveness to the treatments at the two extremes of the income spectrum. While low income households *only* respond to the financial gain mailers, high income groups *only* respond to social incentives. In fact, the average treatment effect of the financial gain inserts (300 litres, or 1.3% on average) is almost fully attributable to the low income groups, whereas the average treatment effect from social recognition is dampened by the low income groups.

For the poorest households (excluding indigent households) in Cape Town, the financial savings insert resulted, on average, in 600 litres of water saved per month (equivalent to a 3.3% decrease in consumption). In contrast, social recognition reduced water usage on average by 520 litres for non-indigents (equivalent to a 2.2% decrease in consumption from the baseline mean). For the wealthiest households, social recognition decreased water consumption by 900 litres each month, on average, which is equivalent to approximately 2.6% from their baseline consumption.

Two vastly different mechanisms - financial incentives and social recognition - lead to behavioural change in our setting. When considering the impact of the financial mailer, which made explicit the financial gains from moving into the lower tariff block, budget constrained households responded to increased salience of water usage and price. The choice environment is complex given the nonlinear pricing structure. More so, even if the household understands the structure and pricing, they cannot monitor water usage throughout the month nor determine their marginal price at time of use with conventional meters. By making the information relevant and clear to the agent, even if just at the end of the billing cycle, it is possible to change their behaviour. Further research should investigate if the impact increases with time-of-use meters.

High income households spend a smaller share of their budget on water relative to low income households and are less responsive to price signals (Brick et al., 2016a). In order to understand behavioural change in this group, we draw inference from Maslow's hierarchy of needs. More specifically, as these households are likely to have their basic physiological needs met (food, water and shelter), we can attempt to change their behaviour by appealing to higher-order needs: love and belonging. By appealing to the need for belonging and acceptance in society, the social recognition treatment motivates behavioural change in our setting. Chapter 5 investigates this channel in further detail.

A strong critique of our intervention is that the mailers are not perfectly comparable: specifically, the tariff graph, financial gains, and social norms interventions depicted images to make the information more clear to the reader. The intrinsic motivation, social recognition, and appeals to the public good mailers did not have images as, at the time of design, we decided images would not add to increased comprehension of the message. In the end, we observe the strongest effects on the inserts without images. However our results may be downward biased if lower income groups relied on images more than text to understand the insert. Furthermore, the social recognition mailer offered a reward at a future date - the results were published on the City's website a few months after the study's completion. Thus monthly feedback was not provided after the first month, as it was in the other treatments, and only at the end of the intervention. A natural concern with behavioural nudges is fatigue[14]. Further research is needed to study the impact both during and post-treatment period (before the results were published) to determine if there was a decay effect over the months. Additional research is also needed to analyse whether households changed behaviour once the results were published publicly by the City.

Another limitation of this analysis is that we do not know which households read their water bills and/or read our inserts accompanying their bill. However, we have no reason not to assume random attrition. We also do not know if the person who read the insert i) pays the water bill and ii) is the main influencer when it comes to enforcing behavioural change in the household. To explore this idea, we will test if sending the inserts with the bill decreased non-payment, and if it decreased non-payments for all utilities or just water.

Given South Africa's extreme income inequality, the finding of asymmetrical treatment effects across income groups highlights the need for better targeting of

[14] Our analysis indicates that the effect of social recognition is equivalent in the once-off treatment (first month) compared to the entire five month long treatment (see short run analysis in the Appendix on Page 261 in Table D.1).

incentives. More broadly, our findings suggest that the behavioural messages significantly reduced consumption - even in a context of extreme water scarcity, and over and above tariff increases and water restrictions - and can lead to greater results when targeted appropriately to different income groups. With a cost-effectiveness estimate of R0.004 (0.0003 USD) per household for the financial treatment, behavioural interventions such as ours are extremely low-cost. And, messages can be adjusted (and substituted) according to varying constraints (or fatigue) faced by households of different income groups.

For further research, we will merge our data with the Census data to analyse heterogeneity not only across income but also race and changes to dwelling infrastructure over time. With access to data on other utilities, we plan to test the assumption that changing behaviour in the water context may have spillovers to other utilities reported on the municipal bill such as electricity usage. Finally, as the municipality is also gripping with issues of non-payment, we plan to test if receiving any of the treatments lead to a significant decrease in default or late payments.

Chapter 5

Image Motivation for prosocial behaviour: *Evidence from South Africa*

5.1 Introduction

"Man naturally desire, not only to be loved but to be lovely... he naturally fears not only be to hated but to be hateful, i.e. a natural and proper object of hatred" - Adam Smith (1790).

Mankind's desire for social approval can be leveraged to drive prosocial behaviour. For example, in a lab setting experiments have demonstrated that revealing identity increases contributions to public goods (Andreoni and Petrie, 2004; Rege and Telle, 2004). Randomised field experiments have used social recognition to increase public good contributions in varying public good contexts, for example, charity contributions, voter turnout and blood donations (Gerber et al. (2008); Lacetera et al. (2011), qtd. in Samek and Sheremeta (2015)).

Social recognition for doing-good creates a signal by distributing information about socially desirable behaviour. However, while social recognition demonstrably facilitates prosocial behaviour, the drivers behind behavioural change are less clear. For example, prosocial behaviour may be intrinsically motivated (irrespective of social recognition), or it may be driven by the desire to be recognised for "good" behaviour in society, raising self-evaluation and welfare derived from the activity (Frey, 1992). It also might be driven by image/reputational motivation, in which case it creates an "impure" form of altruism (Bénabou and Tirole, 2006). Support for image motivation also come from the economics and psychology literature: fear or avoidance of shame motivates individuals to contribute to the welfare of the group (Coricelli et al., 2014). Public commitments and "faming and shaming" campaigns during drought in the south and southwest United States are used to leverage this strand of theory into action (McKinley, 2008).

Conversely, prosocial behaviour could be diminished if intrinsically and image-motivated individuals have misgivings about their behaviour being misconstrued by others as driven by the extrinsic incentive (image motivation). In this instance, social recognition could crowd out prosocial behaviour. These individual impacts of social recognition on motivation are difficult to observe given that, in a field-experiment setting, individuals' heterogeneous social-preferences coalesce and become indistinguishable from one another. Against this background, the aim of this study is to disentangle intrinsic motivation, extrinsic incentives (social recognition) and image motivation.

The extent of desire for social approval (if any) is heterogeneous across a distribution of preferences and perspectives. For example, let us assume driving a Toyota Prius acts as a visible signal of proenvironment behaviour and thus has a reputational value. Motives for buying the Toyota Prius may differ: some might be intrinsically motivated to have a lower carbon footprint while others, who are image motivated, may want to signal environmental concern even in the absence of any intrinsic motivation. Conversely, some intrinsically and image-motivated individuals might refrain from purchasing a Toyota Prius altogether (opting for a more anonymous car) amid concerns that their actions will be misinterpreted as actively seeking social approval (see Ek and Söderholm (2010); Johansson-Stenman and Martinsson (2006) on status concern and green purchase choices).

Bénabou and Tirole's (2006) model on incentives and prosocial behaviour combines heterogeneity in individuals' levels of altruism with reputational concern. As per their model[1], public praise (social recognition) can have an amplifying effect on prosocial behaviour if reputation strengthens the social signal. However if there is any degree of heterogeneity in the individuals' image motivation, the incentive increases the noise-to-signal ratio: public praise could still have an amplifying effect for those who are purely image motivated but lack strong intrinsic motivation; alternatively, it could have a reverse effect for those concerned about appearing interested in public attention (Bénabou and Tirole, 2006). With a high noise-to-signal ratio, the incentive may have an overall net dampening effect and result in limited effectiveness (Bénabou and Tirole, 2006).

This paper's main contribution is an empirical test of Bénabou and Tirole (2006) hypotheses by disentangling intrinsic motivation, extrinsic incentives, and image motivation. More specifically, we test whether (i) extrinsic incentives crowd out intrinsic motivation and, (ii) whether social recognition obscures the signal of prosocial behaviour and ultimately crowds-out cooperation. For (i), we find social recognition as an extrinsic incentive, on average, does not crowd out intrinsic motivation, but rather image motivation, on average, crowds in motivation to conserve. To understand the second question, we analyse if full visibility of the social recognition treatment (image motivation) compared to the same treatment with an explicit opt out option crowds in or out cooperation. We find image motivation crowds *in* cooperation from wealthier households. For these households, the signal of doing-good is strong enough to elicit cooperation. However image motivation crowds *out* cooperation for the indigent[2] sub sample: the signal is noisy and results in an increase in water consumption. We discuss the potential channels for this result in the following sections.

[1]See page 275 in Appendix E for the model as it applies to this study.
[2]Recipients of free or subsidised utility provision given property level and income.

The second main contribution is empirically testing Bénabou and Tirole (2006) hypotheses in a highly unequal developing country where the signal of "doing good" is hypothesised to be noisy. Furthermore, with our results, we are able to provide timely policy advice to government counterparts grappling with finding quick, low cost, and effective policy solutions to the water crisis. We conducted a randomised field experiment on over 220 000[3] households in the City of Cape Town, South Africa, during a severe drought to analyze the impact of social recognition on residential water savings across income groups. Refer to Section 4.4 in Chapter 4 for details on the intervention and experimental setting.

To disentangle pure intrinsic motivation, extrinsic incentives, and reputational value per Bénabou and Tirole's (2006) model, we assigned randomly selected households into one of four treatment groups (approximately 33 000 each) and a control group (approximately 50 000 households). The control group receives only their municipal bill, which details their monthly water consumption. In the first treatment group, an insert (sent with their municipal bill) displays tips (quick fixes and smart purchases) for reducing water consumption. Tips is then replicated on the back sheet of all treatments in our study. A second insert appeals to households' intrinsic motivation to reduce water consumption with a neutral framing by encouraging them to decrease water usage by 10% over the summer months, but offers no extrinsic incentive if they do so. 10% is directly in line with appeals from the public water savings campaign during our study. To then disentangle the effect of image motivation, we exogenously vary the visibility of the non monetary extrinsic incentive (social recognition) using two further treatments: in addition to the information provided in the first treatment, those in the second treatment are additionally told households that do manage to conserve by 10% will be publicly recognised by having their details (name and suburb) published on the City of Cape Town's website. Throughout the text, we refer to this compulsory social recognition as "image motivation". A fourth treatment receives the same message but are

[3]Part of a larger trial on the entire population of free-standing domestic households (440k) in the City of Cape Town, which is inclusive of other treatments not discussed in this paper.

further provided with an explicit opt-out: they are given a number to call should they wish to not have their information published on the website in the event that they reduce consumption by 10%[4]. Please see the Appendix E.2 on page 276 for the inserts.

Overall, 51% of those households allocated to intrinsic motivation, image motivation or social recognition with an opt-out reduced their consumption by 10% over the treatment period[5]. Contrary to Bénabou and Tirole's (2006) model, our results indicate that the image motivation (compulsory social recognition) treatment crowds *in* motivation. If a household received the image motivation treatment they decreased their monthly water consumption on average 2.6% (560 litres of water saved per month) in the once off treatment[6]. We repeat the experiment for five months and find that image motivation still has the highest effect although it is lower: the treatment results in an average decrease of 250 litres per month from a baseline mean of 23.37 kiloliters - equivalent to a 1% decrease. Tips, intrinsic motivation, and social recognition with an opt-out option[7] have an equal effect on water conservation. On average, these three treatments reduce consumption by approximately 130 litres per month, equivalent to a 0.6% decrease in water consumption from the pre-intervention mean.

Thus, in our setting, the signal of social recognition for prosocial behaviour, on average, is strong enough to elicit cooperation. Our findings suggest that social approval is key to galvanizing behavioual change in our setting. However the study points to a stronger potential channel than simply achieving social approval. As households conserved if they received the compulsory ("image motivation") versus the explicit opt-out, our results suggest that revealing identity triggers the fear or

[4]Thus we are also testing the "turning down of rewards" as modeled by Bénabou and Tirole (2006). However Bénabou and Tirole (2006) assume that the issue does not arise if givebacks are not observable to whom actors are trying to signal.

[5]This includes over-estimations for any version of 10% (month on month, month-to-November, April-to-November). The conservative estimate is the 27% if we use only month-to-November.

[6]We use a difference-in-difference model and thus compare treatment versus control and pre - intervention baseline versus intervention outcome.

[7]Approximately 100 households called the hotline over the treatment period to be excluded from the recognition treatment.

avoidance of shame, motivating individuals to contribute to the welfare of society (Coricelli et al., 2014).

In an interesting twist, consistent with Bénabou and Tirole's (2006) hypotheses, our indigent heterogeneity results show that the average treatment effect for image motivation is dampened by the indigent sub sample: whereas the effect magnifies to 520 litres saved (2.2%) in the non-indigent sample, the image motivation treatment *increases* consumption by 580 litres per month for the indigent sub sample. This suggests having one's name publicly recognised is viewed differently by different social groups, thus confirming the noisy signal of doing-good. Specifically, the image motivation crowds *out* motivation in the indigent sub sample. The undermining effect of the incentive leads to an increase in consumption compared to the control group. Potential channels are discussed in the conclusion.

In application to public policy, our findings suggest that for the higher income population, public recognition can be used as an adjunct to more traditional demand side management tools, such as water restrictions and tariff increases, to achieve additional conservation. Importantly, the effect is only observed in the households who use the most water and are least responsive to price signals (Brick et al., 2016a).

The rest of the paper is structured as follows: Section 5.2 presents the theoretical framework which motivates our experiment; Section 5.3 describes the experimental design and setting; Section 5.4 shows descriptives; Section 5.5 the pre trend analyses; Section 5.6 details the empirical strategy; Section 5.7 discusses the results and Section 5.8 concludes.

5.2 Modeling Incentives and Motivation

In economics, rational choice explains behaviour (Friedman, 1953); individuals maximise utility given their constraints. Carrots (rewards) and sticks (sanctions) change these trade-offs (Olson, 1965; Ostrom, 1997). Cognitive psychologists found that an activity can be rewarding of its own, independent of any external reward or sanction; this is called intrinsic motivation (Deci, 1971) or the "warm glow" effect (Andreoni, 1990). Solow (1971) assumed extrinsic incentives were synergetic to behaving altruistically. However, this is not always the case; extrinsic rewards may crowd out intrinsic motivation (Deci and Ryan, 1985; Lane, 1991; Andreoni, 1990; Bénabou and Tirole, 2003; Bénabou and Tirole, 2006).

Frey (1992) introduced the possibility of an external incentive crowding in or crowding out intrinsic motivation into a simple rational choice model. The principal seeks to affect the agent's behaviour with the use of an external instrument. The agent adjusts their optimal choice as the principal adjusts the strength of the instrument. If the cross derivative of the external instrument and intrinsic motivation is non-zero, there is crowding in or out of motivation.

Frey (1992) discerns two conditions that affect this cross derivative - self - determination and self - evaluation. An individual may perceive that the external instrument is used to control or regulate the individual's intrinsic motivation; it diminishes self - determination and therefore welfare. Alternatively, the external instrument may be interpreted as recognition by the principal that the agent is behaving well, raising their self evaluation and thus welfare.

Additionally, a large literature indicates that, independently of monetary incentives, individuals tend to follow social norms (customary rules that prescribe accepted behaviour) (Gneezy and Rustichini, 2000). Within the ambit of social convention, it is possible that a non monetary incentive such as public recognition - which signals the socially acceptable behaviour to others - would promote prosocial behaviour. In the context of water scarcity (which is the backdrop of the current study), we admire those who conserve water and are either ambivalent towards or dishonor those who fail to moderate their consumption (see for example "drought shaming" newspaper articles and mobile apps used in California and Texas to publicly shame high water consumers (McKinley, 2008)).

In contrast, Bénabou and Tirole (2006) examine how the presence of a reward may diminish the value of good deeds, creating doubt as to the extent to which they were performed for the incentives rather than purely out of intrinsic motivation. Such doubt could crowd out prosocial behaviour. While most empirical studies solely analyse the impact of extrinsic incentives on crowding in or out motivation, Bénabou and Tirole (2006) incorporate reputational or "image" concerns into the individual's utility maximization problem. As such, according to their model, extrinsic incentives impact on behaviour through two channels. Firstly, extrinsic motivations might crowd out one's internal justification for a prosocial activity and, secondly, also provide a social signal to others in their environment. According to Bénabou and Tirole (2006), if agents are heterogeneous in their image concerns, the public recognition increases the noise-to-signal ratio, and can dampen the policy's effectiveness.

Bénabou and Tirole's (2006) model helps us to structure our questions and hypotheses at hand as we randomise the visibility of social recognition. We hypothesise that if an individual is intrinsically motivated, then the purely intrinsic motivation treatment - "T2" (see E.11[8]) will prompt them to save water. If this same individual is intrinsically motivated and discouraged by the public recognition due to image concerns, they will either maintain or increase their consumption in response to the image motivation incentive (T3, see E.12). This same individual will instead opt-out of receiving the public reward (T4, see E.13), but will remain intrinsically motivated and decrease their water consumption.

If this individual is purely image motivated, then the neutral treatment (T2, see E.11) will have no effect, and both public recognition treatments might have the same effect of a a decrease in water consumption, yet the individual will not opt out in the opt out treatment (T4, see E.13).

For those who are concerned about appearing greedy for public recognition, they will either maintain or increase their consumption in response to T3 (see E.11). This same individual will opt out of T4 (see E.12) and decrease their consumption. Please see Figures E.11, E.12, and E.13 in Appendix E.3 for graphical examples of the hypothesised effects of each treatment applied to the theory.

[8] T1 is the tips-only treatment

We test the empirical validity of two hypotheses, both of them motivated by economic theory: (i) does an extrinsic incentive (social recognition) crowd out intrinsic motivation? (Frey, 1992) and (ii) does social recognition increase the noise-to-signal ratio and crowd out cooperation? (Bénabou and Tirole, 2006). To test (i), we will compare the effects of the social recognition treatments against the effects of the intrinsic motivation treatment. To test (ii), we will compare the effects of the two social recognition treatments to each other. Specifically we look at whether full visibility leads to higher cooperation.

In addition to empirically testing economic theory, our findings contribute to the literature on public and private recognition for energy savings. Pallak and Cummings (1976) find that soliciting public commitment over a private commitment induces energy savings in the United States. Milinski et al. (2006) similarly find individual investments in climate products are highest if the individual is aware that their decision is public. In a separate study incentivizing customers to allow their utility company to install a remotely-controlled air conditioning device during peak demand in California, customers whose decisions were made public were 1.5 percent more likely to sign up than those whose decisions remained private (Yoeli, 2009). The author also found social approval to be more effective at increasing participation relative to monetary incentives. When trying to incentivise energy conservation in college dorm rooms, Delmas and Lessem (2014) find that private information alone was ineffective, but public information combined with private information motivated a 20% reduction in electricity consumption.

Our analysis relates also to public recognition for charity contributions (Carpenter and Myers, 2010; Soetevent, 2011; Bodner and Prelec, 2003). Faming and shaming in competition has recently been shown to increase contribution to charities (Samek and Sheremeta, 2015). However, we use the household's baseline water consumption as a benchmark to reduce by 10% - as it mirrors the public savings campaign - which importantly removes the element of competition (another potential motivation for public recognition).

Thus our study adds to the literature on the effect of faming and shaming in non-competitive settings. According to Rege and Telle (2004) and Milinski et al. (2006) people coordinate to improve their self image and reputation and to avoid shame. Our contribution is analysing the impacts of naming and praising water savers and teasing out the impact of visibility on contribution. Few studies have empirically tested when image motivation incentives crowd out intrinsic motivation. Separating the effect of the potential "greedy signal" from social recognition, Exley (2014) examines three image-related effects in a lab experiment: i) the Negative Image Effect, whereby public incentives compared to private incentives discourage public volunteerism; ii) the Reputations Effect, whereby public reputations potentially decreases the strength of the prosocial signal; and iii) the Interactions Effect. She uses a lab experiment to show that a crowd-out in response to public incentives is much less likely among those with public, as opposed to private, reputations. The strength of the greedy signal might be a determinant of the outcome. As Exley (2014) explains, mixed empirical findings in the literature show a net positive effect when the studies involve established volunteers with likely public reputations (Carpenter and Myers (2010), qtd. in Exley (2014); Lacetera et al. (2012, 2011) qtd. in Exley (2014)), and the backfire effect is observed when public volunteer behaviour is unestablished (Gneezy and Rustichini, 2000; Mellström and Johannesson, 2008; Ariely et al., 2009).

5.3 Experimental Setting

For details on the experimental setting and timeline of the roll-out, please refer to Chapter 4.

5.3.1 Treatments

Message 1: Tips

See Section 4.3 in Chapter 4 for the description on the tips treatment. Again, the tips treatment is repeated in all subsequent treatments to control for availability of information: if households are motivated to change behaviour due to the insert, then all households across treatments should be provided examples of ways to conserve water. An example of the tip sheet is provided in Appendix E.1.

While Section 4.3 in Chapter 4 also details Intrinsic Motivation and Social Recognition (image motivation), we include them here to more readily explain the nuances between these and additional the social recognition treatment with an opt-out.

Message 2: Neutral framing/Intrinsic motivation

This treatment asks households to voluntary reduce their water consumption by 10% in order to support a water saving initiative that was recently launched by the City. This figure is directly in line with the appeal from the public savings campaign to reduce consumption by 10%. It offers no extrinsic incentive to do so. The insert is provided in Appendix E.3.

Message 3: Image Motivation

As with Message 2 (Intrinsic motivation), this treatment encourages households to reduce their water consumption by 10% in order to support a water saving initiative that was recently launched by the City. However, in addition, the message further states households that achieve this goal over a six-month period will be publicly recognised on the City's website. The reader is referred to Appendix E.5.

In comparison to Message 2, where the motivation to conserve water is internal, this framing explores whether the opportunity to be socially recognised as one of the best performers (water savers) promotes conservation. If people desire to appear to their society that they are doing good deeds, then it follows that the opportunity to be socially recognised promotes conservation.

Message 4: Social Recognition (Opt-out)

This message is the same as Message 3 (Image Motivation) with the exception that households are explicitly given the ability to opt-out of having their names published on the City's website: as evident from Appendix E.7, households are provided a number to call should they wish to not have their name published.

The latter two messages test whether social recognition crowds out intrinsic motivation. For example, the imposition of social recognition (whether there is an option to opt-out or not) upon intrinsically-motivated individuals might well reduce their water-saving attempts relative to Message 2 (Intrinsic motivation). The call number was explicitly for those who want to opt out of the contest (for opt out of the prize, see below). See Appendix E.7.

Households receiving Message 2, 3, and 4 received a new insert with their May bill informing them if they succeeded in achieving a 10% reduction in water consumption over the treatment period. Only the social recognition treatments (Messages 3 and 4) were provided the website address where their names will be published if they achieved the 10% savings. For ethical reasons, both treatments were given an opt-out for the website publication at the end of the treatment period[9]. See Appendix E.9.

5.3.2 Sample

Please see in Chapter 4 for details on the entire sample and power calculations.

The sample sizes allocated to the control group as well as the treatments discussed here are reflected in Table 5.1.

[9]We recorded each account number, reason for opt out, and for which insert they were calling in reference to. Less than 100 households in the image motivation treatment opt-ed out at the end of the experiment, and thus we do not have enough power to analyse this sample.

Table 5.1: Sample sizes for the control and treatment groups

Treatment/message group	Allocated to treatment
Control	48 206
Tips	49 928
Intrinsic motivation	40 058
Image Motivation	44 174
Social recog. (opt out)	43 930
Total	**226 296**

The numbers in Table 5.1 reflect the total numbers allocated to each treatment. Sample sizes changed during implementation due to several factors; in a given month, households with estimated meter readings do not receive a message (so as not to give households inaccurate information) as well as households with billing periods greater than 35 days (which is usually indicative of a billing reversal or problematic bill). Finally, so as not to put low-income households in a vulnerable state, only households consuming in excess of the six kiloliter free monthly allocation receive a message.[10]

5.4 Summary statistics

This section provides Some summary statistics for the months of November and December 2015 when the initiative was launched.

5.4.1 Initial treatment allocations

Table 5.1 indicates the number of households allocated to the control group and each of the four treatment groups in the first month of the experiment (November). As previously discussed, not all households will receive an insert in a particular month. Specifically, a household will not receive an insert if:

- They are in tariff block 1
- Their bill is an estimated reading

[10] As per South Africa's Free Basic Water Policy, all households are provided with a free water allocation of six kilolitres per month.

- Their billing period is 35 days or more
- Their bill has been referred back to the City ("Referrals")

Against all these conditions, Table 5.2 denotes the number of households that actually received an insert in the month of November (139 438 households).

Table 5.2: Number of households receiving inserts in November 2015

	Inserts Mailed
Tips	41 312
Intrinsic motivation	32 837
Image Motivation	29 158
Social Recognition: Opt Out	36 131
Total	**139 438**

Note: SR English did not receive inserts during the first five portions in November.

As evident from the table, we experienced operational issues during the first five billing portions (1st to 5th of the month) in November whereby the inserts for the image motivation treatment (English only) were not printed. In order to accommodate those households who did not receive an insert in November, these households received their first treatment at the beginning of December and were messaged through the beginning of May. We control for this in all regressions and also perform robustness checks where we alter the control group to mirror the late receivers.

5.4.2 Final changes to treatment allocations

As described previously, households in the social recognition treatment are asked to reduce consumption by 10% relative to their consumption in November (or December in the case of those households that did not receive an insert in portions 1-5 in November). However, there were a number of households who did not receive the social recognition inserts in November because of being in tariff block 1, receiving an estimated reading or having a reading period of greater than 35 days. As they did not receive the insert, we reallocated these households equally across the remaining treatments (tips, graph, gain, loss, social norm and public good, see Chapter 5). The updated treatment allocation is reflected in Table 5.3.

Table 5.3: Treatment re-allocation from December 2015

Treatment/message group	Allocated to treatment
Control	51 113
Tips	52 833
Intrinsic motivation	32 724
Image Motivation	38 557
Social recognition (opt out)	36 014
Total	**211 241**

5.4.3 Randomisation

We test whether the treatment and control groups are balanced in terms of several demographic characteristics, namely, monthly consumption, daily average consumption, number of billing days (over the month) and property value. The means, standard deviations, and p-value of the t-tests for difference in means is shown in Table 5.4. Note, this is the reallocation sample after issues in the November billing. Thus there is some imbalance in the tables due to the need to reallocate and also, due to the first 5 portions of English speakers not receiving inserts (and received their first insert with their December bill instead). We control for all observables in the regressions, use difference-in-difference with trend methods in addition to pooled regressions, and include robustness checks where we alter the control group for the late receivers.

Table 5.4: Demographic characteristics by treatment group for October 2015 [11]

		Treatment mean	Treatment s.d.	Control mean	Control s.d.	T-test of means (p-value)	Observations
Consumption (kl)	Tips	21.77	39.69	22.55	104.73	0.121	49 928
	Intrinsic Motivation	22.11	108.12	22.55	104.73	0.559	40 058
	Image Motivation	22.14	33.68	22.55	104.73	0.487	44 174
	SR Opt Out	22.46	45.68	22.55	104.73	0.87	43 930
Daily average (kl)	Tips	0.67	0.92	0.67	2.3	0.952	49 928
	Intrinsic Motivation	0.65	0.96	0.67	2.3	0.336	40 058
	Image Motivation	0.65	1.07	0.67	2.3	0.271	44 174
	SR Opt Out	0.68	0.88	0.67	2.3	0.312	43 930
Property Value ($R)	Tips	741 097.72	1 111 771	727 149.37	1 073 219	0.051	49 928
	Intrinsic Motivation	679 334.14	1 000 515.4	727 149.37	1 073 219	0	40 058
	Image Motivation	718 531.62	1 091 643.2	727 149.37	1 073 219	0.262	44 174
	SR Opt Out	704 014.68	1 087 076.3	727 149.37	1 073 219	0.001	43 930
Billing period (days)	Tips	32.96	24.26	33.26	26.24	0.06	49 928
	Intrinsic Motivation	32.73	24.32	33.26	26.24	0.003	40 058
	Image Motivation	32.7	23.56	33.26	26.24	0.001	44 174
	SR Opt Out	33.11	26.6	33.26	26.24	0.377	43 930
Tariff block	Tips	3.17	1.03	3.15	1.01	0.001	49 928
	Intrinsic Motivation	3.16	1.01	3.15	1.01	0.406	40 058
	Image Motivation	3.17	1	3.15	1.01	0.034	44 174
	SR Opt Out	3.2	1.07	3.15	1.01	0	43 930
Indigent Status	Tips	0.32	0.47	0.33	0.47	0.208	49 928
	Intrinsic Motivation	0.39	0.49	0.33	0.47	0	40 058
	Image Motivation	0.35	0.48	0.33	0.47	0	44 174
	SR Opt Out	0.38	0.49	0.33	0.47	0	43 930

It is important to note the indigent sample. As it is not balanced, we will control for them in all regressions. As stated, indigent status is granted to a subset of the poorest population whose property value is under R300 000 or households who are considered eligible after a means assessment. These particular indigents qualify for a stipend for their water bill (a reduction of R53.27 on each bill). Indigents typically consume on average less water than non-indgents (an average of 18.32 kl over the entire panel, versus 19.45kl for non-indigents). The indigents make up approximately 41% of our sample.

5.5 Pre-intervention consumption analysis

As mentioned in Chapter 4, we received historical consumption data after the randomisation. In order to control for seasonality, we chose to use December 2014 to April 2015 data as the pre-intervention baseline period in our analysis. Figure 5.1 graphically depicts water use trends in the pre-intervention period for the sample of interest in this paper. Identical to what we see in Chapter 4, from Figure 5.1 it is evident that there is a seasonal component to water usage: specifically, average monthly consumption is higher in the warmer summer months. December consumption (January bill) is often the highest as households are home for more days of the month due to the holidays. The graph depicts an absolute increase in water consumption and an effect coming in from an increase in billing period as the City works on skeleton staff during the holiday season. Figure 5.2 indicates that the billing period is broadly consistent across treatment and control groups. All groups experience a spike in average billing days around January/February. Given the data depicted in these graphs, we need to control for seasonality effects. We control for month-fixed effects in all of our models due to the increase in consumption in January. This graph also shows similar trends in treatment and control groups, which supports the parallel trends assumption for our difference-in-difference model.

Table 5.5 tests if the sample is balanced across treatment and control groups for

[11] Data used for randomisation

Figure 5.1: Mean monthly consumption by Treatment group

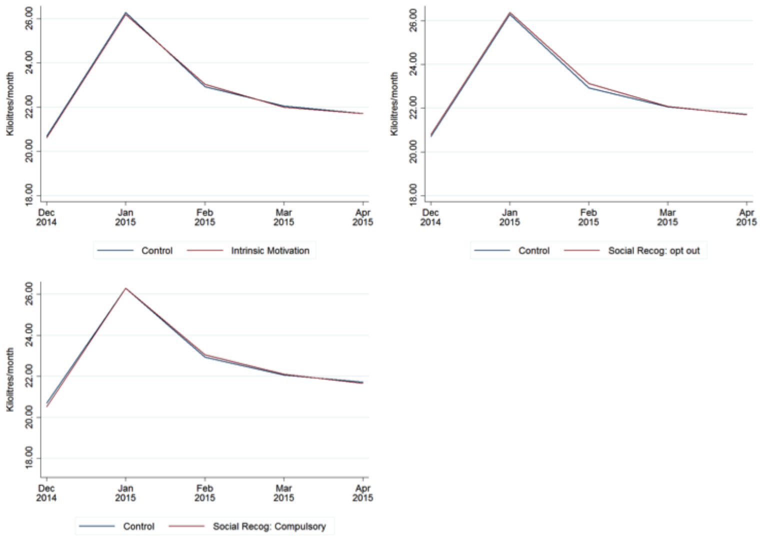
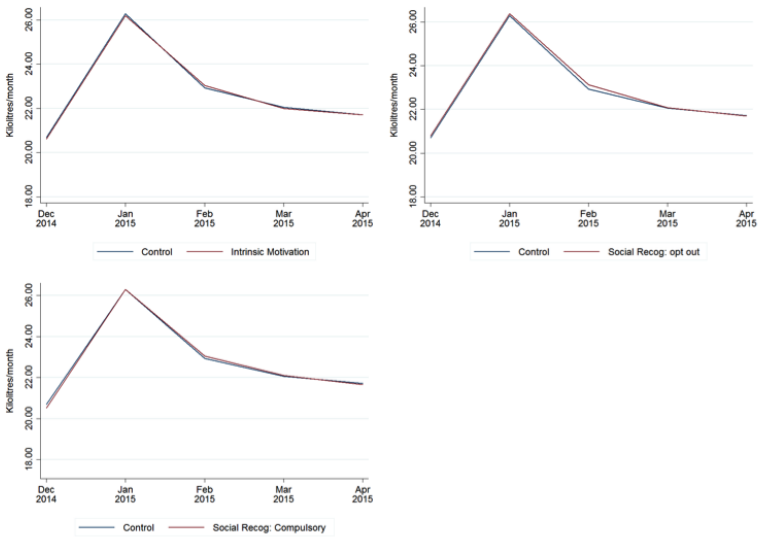


Figure 5.2: Mean billing days by Treatment group



the pre-intervention period. The estimates reported in 5.5 are based on a regression of the outcome variable/characteristic as the dependent variable and dummy variables for the four treatment groups (omitting the control group) as explanatory variables. Following Bruhn and McKenzie (2009), we control for stratification by including tariff block and suburb dummy variables in the regressions.[12] The table indicates that the treatment and control groups are balanced on key characteristics

[12]As households frequently changed tariff blocks throughout the course of the study, we designated the household the tariff block the household was in in October 2015 when the randomization was conducted. The same procedure was used for suburb.

such as consumption and number of billings days. Regardless, we include all as controls in the regressions.

Table 5.5: Balance tests with pre-intervention data (December 2014 - April 2015)

	I Means	II Monthly consumption (kl)	III Daily average (kl)	IV Property Value ($R)	V Billing period (days)	VI TB_baseline
Tips	20.86	0.003	0.038	-0.002	-2 652.741	0.003
		0.007	0.081	0.003	3 627.477	0.007
Intrinsic motivation	20.59	-0.002	0.174**	0.004	367.503	-0.002
		0.007	0.084	0.004	3 705.814	0.007
Image Motivation	21.00	0.108***	0.127	0	94.626	0.108***
		0.028	0.085	0.004	4 052.323	0.028
SR opt-out	20.65	-0.002	0.115	0.001	4 547.779	-0.002
		0.007	0.077	0.003	3 861.908	0.007
Constant		30.383***	15.722***	0.529***	804 726.811***	30.383***
		0.013	0.177	0.006	7 200.799	0.013
Indigent status		Yes	Yes	Yes	Yes	Yes
TB fixed effects		Yes	Yes	Yes	Yes	Yes
Suburb fixed effects		Yes	Yes	Yes	Yes	Yes
Observations		1 186 621	1 186 621	1 186 621	1 126 282	1 186 621
Treated		1 044 622	1 044 622	1 044 622	991 028	1 044 622
Intrinsic Motivation		107 981	107 981	107 981	103 323	107 981
Image Motivation		126 378	126 378	126 378	120 301	126 378
SR opt-out		122 610	122 610	122 610	116 594	122 610
Control		141 999	141 999	141 999	135 254	141 999
Fpvalue		0	0.492	0.911	0.131	0
R-squared		0.019	0.411	0.211	0.719	0.019

As in Chapter 4, we follow Abramitzky and Lavy (2014) by using pre-intervention data from December 2014 to April 2015 to determine whether the treatment and control groups have differential time trends with respect to water usage. Means are reported in Table 4.7. The estimated results are reflected in Table 5.6. Again Panel A reflects the results of a constant linear time trend model which allows for an interaction of the trend with the treatment indicator, while, in Panel B, the linear time trend variable is replaced by a series of month dummies as well as an interaction of the treatment indicator with each of these time dummies (Abramitzky and Lavy, 2014). While the results from both models confirm the presence of a time trend with respect to water usage, in general this trend is identical for treated and non-treated households.

The results in Panel A suggest that, on average, water consumption decreases by 180 liters per month. However, as evident by the interaction term (Treatment X Trend), this trend does not differ significantly for treatment and control groups. The estimates in the dummies model (Panel B) however, shows the underlying heterogeneity in the trend: many of the interaction terms (of the treatment indicator with the month dummies) are significant and thus we must control for trend in our regressions.

Table 5.6: Differences in the time trend of water usage in treated and control households, Dec 2014 - April 2015

	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)
	Tips	Intrinsic Motivation	Image Motivation	SR Opt-Out
Panel A				
Pre-intervention trend	-0.182***	-0.177***	-0.180***	-0.182***
	0.037	0.037	0.037	0.036
Treatment	0.116	0.136	0.307**	0.208*
	0.109	0.124	0.135	0.113
Treat x Pre-trend	-0.028	0.012	-0.055*	-0.031
	0.023	0.026	0.03	0.027
Panel B				
Treat	-0.071	0.181*	0.482***	0
	0.094	0.1	0.103	0.095
Dec-14	-1.121***	-1.138***	-1.133***	-1.119***
	0.177	0.177	0.179	0.176
Jan-15	4.714***	4.700***	4.709***	4.716***
	0.25	0.25	0.248	0.25
Feb-15	1.053***	1.048***	1.056***	1.058***
	0.262	0.261	0.262	0.261
Mar-15	0.374***	0.371***	0.366***	0.375***
	0.127	0.128	0.128	0.127
Apr-15	0	0	0	0
	.	.	.	.
DEC2014 x treat	0.128	0.105	0.178	0.124
	0.087	-0.132	0.144	0.109
JAN2015 x treat	0.119	0.13	0.249	0.148
	0.125	0.097	-1.047***	0.122
FEB2015 x treat	0.156*	0.114	0.219	0.220**
	0.094	-0.017	-0.663***	0.108
MAR2015 x treat	0.1	0.095	0.14	0.083
	0.082	0	0	0.088
APR2015 x treat	0	.	.	0
	.		.	.
Constant	14.671***	14.691***	14.646***	14.797***
	0.235	0.249	0.229	0.249
Indigent status	Yes	Yes	Yes	Yes
TB fixed effects	Yes	Yes	Yes	Yes
Suburb fixed effects	Yes	Yes	Yes	Yes
Observations	286 621	249 980	264 609	262 100
Treated	144 622	107 981	122 610	120 101
Control	141 999	141 999	141 999	141 999
R-squared	0.42	0.418	0.423	0.416

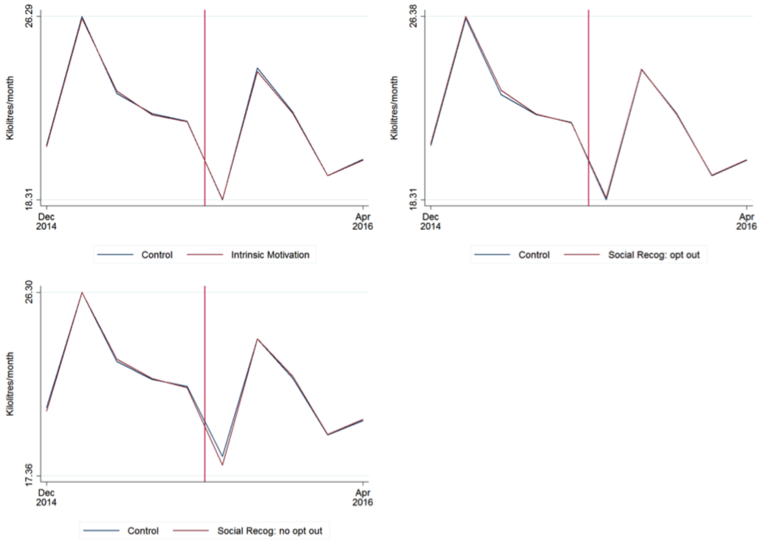
Notes: Regressions include tariff block and suburb fixed effects.
Standard errors are clustered at the suburb level and are presented in parenthesis
Regressions are run for the pre-intervention period of December 2014 - April 2015

5.6 Identification Strategy

We also observe a significant decrease in the overall trend as seen in Figure 5.3 below, so we employ the same Difference-in-difference methods as our main method to compare the effect of our treatments on water consumption in household i. See

Section of Chapter 4 for details on the identification strategy.

Figure 5.3: Mean consumption, Dec 2014 - April 2015 and Dec 2015 - April 2016, by Treatment



5.7 Experimental results with DiD

For robustness we use three outcome measures for the pooled regressions: monthly consumption, relative consumption (compared to the same month in the year prior), and daily average. See Tables E.2, E.3, E.4 in Appendix E.4. In the pooled regressions, across all specifications and outcome variables, the treatments had an equal and significantly negative effect on consumption (approximately 180 litres each month). In the indigent heterogeneity analysis, we see the size of the treatment effect increases to 220 litres each month for the non-indigents.

However our main model is the difference-in-difference which provides better identification for our study as it controls for time trend across all groups.

Image motivation is the only treatment which shows an effect in the short run. Table E.1 in Appendix E.4 provides the regression results for the difference-in-difference with fixed effects estimates for the once- off treatment. Image motivation reduces water consumption on average 590 litres per month (Column IV).

Table 5.7 presents the results for the long run treatment which uses the full panel of five months. Table 5.8 (below) presents the results for the income quintile regressions.

In the longer run analysis (Table 5.7), the average treatment effect for those who received the image motivation treatment compared to the control is a decrease of 257 litres per month (column III) from a baseline mean of 23.37 kiloliters (1.1% decrease). This magnifies to 518 litres saved per month for the non-indigent sub sample when we analyse heterogeneity effects (column VII): image motivation has a 2.2% decrease on consumption per month in the non-indigent households. This is equivalent to 43 toilet flushes assuming an older inefficient toilet which uses 12 litres to flush.

The average treatment effect (260 litres) is dampened by the indigents - image motivation actually increases consumption by 560 litres in the indigent sub sample in the heterogeneity analysis (see column IX). This suggests having one's name posted publicly is viewed differently by different social groups.

Tips has a consistent significant decrease on consumption across specifications, decreasing water consumption by approximately 125 litres (column III), which magnifies to 215 litres saved (column VII). Again we see that the increase in effect size amongst the non-indigents in the heterogeneity analysis (column VII). Indigents, on the other hand, increase their consumption by 283 litres.

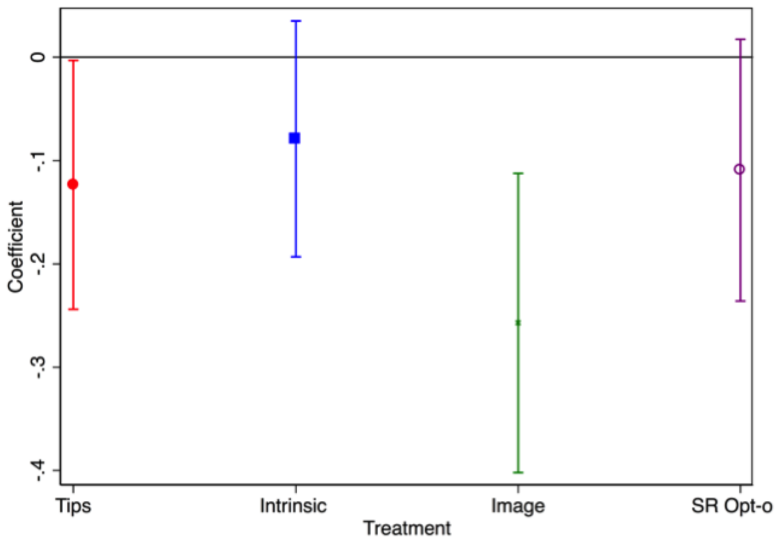
Intrinsic motivation, and social recognition with an opt-out option, have an equal and significant reduction in consumption for non-indigents (no significant findings in the indigent sub sample): these treatments decrease consumption by 292 litres (intrinsic motivation) and 250 litres (social recognition with an opt-out), equivalent to a 1% decease in consumption from the pre-intervention period (Dec 2014 - April 2015). In the basic model (column I), we see on average, these treatments reduce consumption by approximately 130 litres per month, equivalent to a 0.6% decrease in water consumption from the pre-intervention mean.

We also include robustness checks for the late receivers by creating a counter-factual control group which balances the dates and sample for which we analyze consumption (found in Table E.7 in Appendix E). The results are nearly identical: intrinsic motivation and social recognition are not significant. Image motivation is significant and reduces consumption approximately 250 litres (Column 5). In the indigent heterogeneity analysis, this increases to 520 litres saved. Intrinsic motivation (300 litres) and social recognition with an opt-out (280 litres) are significant and negative for the non-indigent sample. Image motivation leads to an increase of 500 litres on average in indigent households. See Table E.7.

Thus, only the non-indigents from our sample respond well to the image motivation treatment, and to a lesser degree, the three other treatments. None of the treatments resonate with the indigents. To investigate if this heterogeneity derives from the income effect whereby indigents have lower income on average than the rest of the sample, or, because they receive a subsidy for (or free provision of) utilities and thus do not internalise incentives sent with the municipal bill, we analyse the treatment effects by income quintile. See next section.

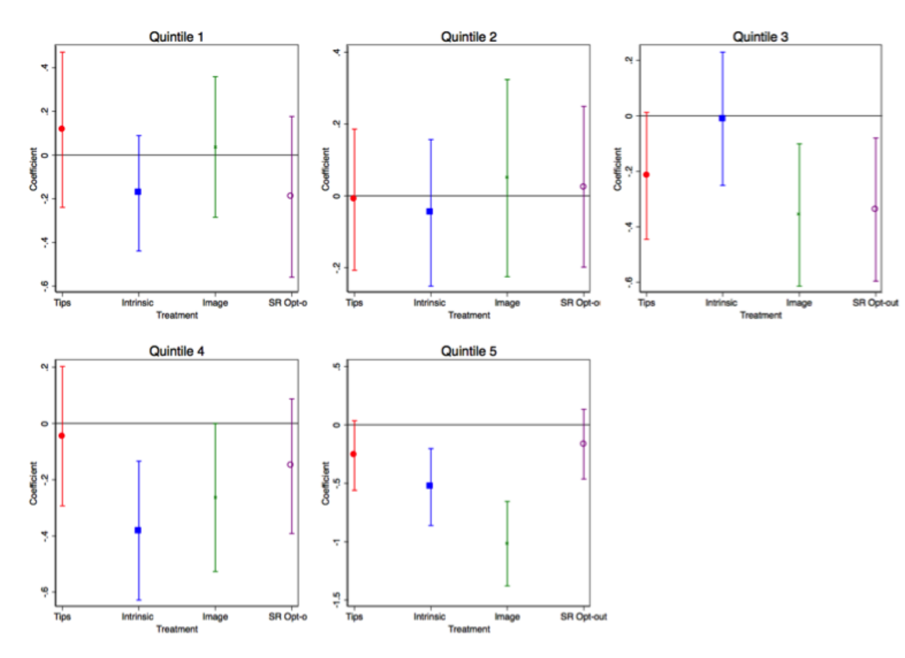
Table 5.7 reflects the estimates from the panel from five months of inserts (December 2015- April 2016 panel). Figure 5.4 graphs the coefficients.

Figure 5.4: Graphical representation of the coefficients (Column 3 and Column 7 in Table 5.7



Differences with regards to heterogeneity across the sample is also poignant when we consider the impacts for different income quintiles. See Table 5.8, and graphical

Figure 5.5: Graphical Representation of Coefficients in Income Quintile Analysis



representation of the coefficients in Figure 5.5.

In particular, none of our treatments have any effect on the lowest (first and second quintile) income groups.

Social recognition - both image motivation and with an opt-out - have an equal and significant impact on conservation efforts for the middle quintile. Both types of social recognition decrease consumption on average by 340 litres (1.7%).

However the effect from social recognition with an explicit opt-out disappears in the highest quintiles (fourth and fifth). Interestingly, intrinsic motivation has the greatest impact on water conservation for the fourth income quintile. Intrinsic motivation on average decreased consumption by 380 litres, equivalent to a 1.6% decrease in consumption. In contrast, the image motivation treatment decreases consumption by 280 litres, equivalent to a 1.2% decrease. Thus for the fourth income quintile, image motivation crowds out intrinsic motivation. However, the effect is only marginal: households in the fourth income quintile still conserve water if given the image motivation treatment, it is just to lesser extent than if they were provided an appeal to their intrinsic motivation.

In the highest quintile, image motivation crowds in motivation: the treatment reduces consumption by a remarkable 980 litres on average, which is equivalent to 2.8% decrease.

Its impact therefore more or less doubles from the impact it had on the third and fourth income quintiles. Intrinsic motivation also reduced consumption by 550 litres on average, equivalent to a 1.6% effect.

Table 5.7: Longer run analysis (Dec 2015 - April 2016): Difference in difference model using fixed effects with trend

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VII Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)
Tips x Post	-0.137*	-0.127*	-0.124*	-0.123*	-0.099	-0.203**	-0.215***	-0.203***	-0.196**
	0.072	0.072	0.073	0.064	0.073	0.081	0.082	0.073	0.084
Intrinsic x Post	-0.123*	-0.101	-0.079	-0.079	-0.063	-0.292***	-0.292***	-0.282***	-0.278***
	0.068	0.067	0.069	0.062	0.07	0.087	0.089	0.081	0.088
Image Motivation x Post	-0.252***	-0.247***	-0.257***	-0.278***	-0.240***	-0.502***	-0.518***	-0.522***	-0.510***
	0.085	0.084	0.088	0.079	0.089	0.096	0.097	0.089	0.099
SR Opt Out x Post	-0.139*	-0.115	-0.109	-0.108	-0.077	-0.242***	-0.250***	-0.234***	-0.234***
	0.076	0.075	0.077	0.068	0.078	0.085	0.085	0.077	0.086
Trend	-0.190***	-0.193***	-0.184***	-0.210***	-0.197***	-0.270***	-0.264***	-0.285***	-0.279***
	0.028	0.015	0.016	0.014	0.016	0.015	0.015	0.014	0.016
Indigent status		2.369***	2.398***	2.415***	2.022***	1.443***	1.446***	1.447***	0.994***
		0.319	0.33	0.338	0.327	0.39	0.388	0.388	0.365
Frequency (-1)			-0.027				-0.014		
			0.038				0.038		
Billed amount (-1)				0.005***				0.005***	
				0				0	
Tariff rate (-1)					-0.053***				-0.053***
					0.004				0.004
Post x indigent						2.173***	2.157***	2.107***	2.289***
						0.234	0.238	0.223	0.266
Tips x indigent						-0.054	-0.004	0.064	-0.118
						0.255	0.25	0.239	0.273
Intrinsic x indigent						-0.445	-0.46	-0.368	-0.341
						0.321	0.324	0.304	0.354
Image Motivation x indigent						-0.438	-0.426	-0.331	-0.509
						0.307	0.307	0.287	0.331
SR Opt out x indigent						-0.115	-0.134	-0.099	-0.036
						0.3	0.286	0.278	0.322
Tips x indigent x Post						0.258	0.283*	0.248*	0.300*
						0.158	0.161	0.14	0.157
Intrinsic x indigent x Post						0.162	0.192	0.174	0.166
						0.141	0.145	0.131	0.149

Image Motivation x indigent x Post						0.527***	0.541***	0.495***	0.556***
						0.166	0.172	0.156	0.171
SR Opt Out x indigent x Post						0.181	0.178	0.143	0.203
						0.174	0.176	0.156	0.178
Constant	23.720***	26.258***	26.352***	25.354***	27.388***	27.042***	27.048***	26.014***	28.125***
	0.195	0.323	0.313	0.362	0.308	0.328	0.311	0.359	0.309
Observations	1 380 281	1 380 281	1 307 866	1 307 866	1 167 551	1 327 866	1 307 866	1 307 866	1 167 551
Treated	1 075 276	1 075 276	1 027 405	1 027 405	917 123	1 043 132	1 027 405	1 027 405	917 123
Tips	313 199	313 199	291 135	291 135	260 033	295 668	291 135	291 135	260 033
Intrinsic Motivation	235 372	235 372	228 258	228 258	203 723	231 838	228 258	228 258	203 723
Image Motivation	265 693	265 693	254 714	254 714	227 136	258 300	254 714	254 714	227 136
SR Opt Out	261 012	261 012	253 298	253 298	226 231	257 326	253 298	253 298	226 231
Control	305 005	305 005	280 461	280 461	250 428	284 734	280 461	280 461	250 428
Clusters	653	653	653	653	653	653	653	653	653
Fpvalue	0.058	0.067	0.065	0.012	0.105	0	0	0	0
R-squared	0.012	0.072	0.074	0.094	0.086	0.077	0.079	0.098	0.091

Standard errors are clustered at the suburb level and are presented under the coefficient

Table 5.8: Income Quintile Analysis: Difference in Difference model using fixed effects with trend

	1st Income Quintile		2nd Income Quintile		3rd Income Quintile		4th Income Quintile	5th Income Quintile
	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VII Monthly consumption (kl)	VIII Monthly consumption (kl)
Tips x Post	0.116	0.705	-0.011	-0.104	-0.216	-0.236*	-0.045	-0.262
	0.215	0.803	0.119	0.171	0.139	0.135	0.15	0.18
Intrinsic x Post	-0.175	-0.108	-0.047	-0.167	-0.011	-0.041	-0.381**	-0.532***
	0.16	0.602	0.124	0.251	0.146	0.143	0.15	0.199
Image Motivation x Post	0.037	0.733	0.049	-0.131	-0.357**	-0.373**	-0.263*	-1.017***
	0.195	0.513	0.166	0.228	0.156	0.152	0.159	0.22
SR Opt Out x Post	-0.191	0.654	0.025	-0.203	-0.338**	-0.363**	-0.152	-0.165
	0.222	0.489	0.136	0.226	0.156	0.156	0.145	0.181
Trend	-0.056	-0.083	-0.124***	-0.122***	-0.173***	-0.171***	-0.252***	-0.303***
	0.042	0.077	0.026	0.028	0.021	0.021	0.026	0.029
Indigent status	2.879***	2.513***	2.391***	2.504***	-0.521	2.044	-0.042	1.053
	0.343	0.391	0.366	0.455	0.445	1.923	0.897	4.13
Frequency (-1)	0.203***	0.202***	0.153***	0.153***	0.207***	0.207***	-0.032	-0.693***
	0.063	0.063	0.057	0.057	0.052	0.051	0.062	0.081
Post x indigent		0.266		-0.039		-2.773*		
		0.645		0.258		1.515		
Tips x indigent		0.662*		-0.083		-2.234		
		0.392		0.316		2.046		
Intrinsic x indigent		0.536		-0.374		-3.581*		
		0.468		0.376		2.15		
Image Motivation x indigent		0.116		-0.467		-1.857		
		0.383		0.443		2.191		
SR Opt out x indigent		0.794*		0.025		-2.957		
		0.431		0.326		2.264		
Tips x indigent x Post		-0.626		0.147		2.145		
		0.817		0.237		1.635		
Intrinsic x indigent x Post		-0.079		0.183		2.9		
		0.625		0.275		1.919		
Image Motivation x indigent x Post		-0.725		0.279		2.117		
		0.507		0.289		1.962		
SR Opt Out x indigent x Post		-0.896*		0.338		2.639		
		0.465		0.258		2.039		
Constant	18.160***	18.215***	19.811***	19.844***	24.163***	24.148***	29.949***	41.164***
	0.66	0.75	0.543	0.519	0.435	0.435	0.362	0.481

Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Suburb fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tariff fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	283 131	283 131	274 057	274 057	220 490	220 490	238 139	230 685
Treated	226 361	226 361	217 123	217 123	171 355	171 355	184 547	179 854
Tips	58 873	58 873	58 215	58 215	50 485	50 485	55 490	53 803
Intrinsic Motivation	55 102	55 102	50 772	50 772	36 813	36 813	38 327	37 210
Image Motivation	55 695	55 695	54 267	54 267	41 903	41 903	45 707	44 630
SR Opt-Out	56 691	56 691	53 869	53 869	42 154	42 154	45 023	44 211
Control	56 770	56 770	56 934	56 934	49 135	49 135	53 592	50 831
Clusters	180	180	260	260	351	351	423	427
Fpvalue	0.496	0.307	0.968	0.911	0.084	0.063	0.044	0
R-squared	0.043	0.043	0.062	0.062	0.077	0.077	0.119	0.137

Standard errors are clustered at the suburb level and are presented under the coefficient

5.8 Discussion and Concluding Remarks

Making individual behaviour observable has been shown to increase contributions to public goods in lab experiments. The tendency to seek social approval in human behaviour could be leveraged in public policy to achieve socially optimal outcomes. However, Bénabou and Tirole (2006) challenge this generalised statement by showing that the introduction of a public reward (recognition) might cast doubt on the true motive of the behaviour, and could crowd out cooperation if the individual is concerned about the noisy signal of their do-good behaviour.

We test Bénabou and Tirole's (2006) hypotheses by conducting a randomised field experiment throughout the City of Cape Town, South Africa to investigate the impact of social recognition treatments on water consumption in times of drought. To our knowledge, this empirical analysis has not been executed elsewhere and contributes both to the academic literature as well as policy recommendations for alternatives to traditional demand side management tools during times of resource scarcity.

Our sample is approximately 220 000 randomly selected households, stratified across income and water consumption bands. 40% of the sample are indigent recipients - a subset of poor households who receive utility subsidies from the government - and 60% non-indigents. We find support both for and against Bénabou and Tirole's (2006) hypotheses: image motivation crowds in motivation for our full sample (and thus the signal of good-doing is strong enough to elicit cooperation), it *marginally* crowds out[13] intrinsic motivation in the 4th income quintile, and it unequivocally crowds out motivation in the indigent sub sample.

We varied whether the household received a neutral framing to reduce their water consumption (an appeal to their intrinsic motivation) or a combination of an appeal to their intrinsic motivation as well as an extrinsic incentive, namely: social recognition. We exogenously varied the visibility of the public prosocial signal by

[13]Households in the fourth income quintile still conserve water if given the image motivation treatment, it is just to lesser extent than if they were provided an appeal to their intrinsic motivation.

adding an additional treatment where households were given the option to opt-out of the recognition incentive. Thus the household still had the ability to conserve but could opt- out of the public award and only receive the private feedback, obviating the potential noisy signal of their good-doing.

For the average household in our setting, image motivation does not increase the noise of the prosocial signal (which might otherwise crowd-out cooperation), and thus we cannot confirm Bénabou and Tirole's (2006) hypothesis. While we do not find significant effects on the social recognition treatment with an opt-out, consumption reduced on average over 520 litres per month if the household was assigned the image motivation treatment - equivalent to 2.2% in relative consumption - compared to the control group. This is in line with the success of crowdsourced "drought shaming" campaigns in the United States, which have been effective at distributing a public signal of socially desirable behaviour by identifying and shaming high water users. While we do not directly "shame" non-water savers due to ethical reasons, the absence of their name in a public domain reserved for the City's water savers might be seen as a passive shaming[14]. However, the channel of avoidance or fear of shame is suggestive in our setting.

In the income quintile regressions, we observe that none of the treatments had an effect on the poorest households. The middle income quintile of our sample decreased consumption equally in both social recognition treatments (opt-out and image motivation). Social recognition with an opt-out had no impact on the fourth and fifth quintiles. Rather intrinsic motivation (fourth quintile) and image motivation (fifth quintile) had the highest impacts. Image motivation in the wealthiest households reduced consumption by almost 1000 litres on average each month.

However, when one considers indigent sub sample alone, then we do find support for Bénabou and Tirole's (2006) hypothesis. The image motivation treatment *increases* consumption (560 litres per month) for these households. Thus the noisy

[14]Households who received the image motivation treatment should assume everyone received the same insert. Thus if the household was curious about their neighbours, their neighbour's absence from the list would indicate a lack of water savings. Whereas for the opt-out, absence from the list is indicative either of the household opt-ing out, or, becaause they didn't conserve water.

signal as hypothesised by Bénabou and Tirole's (2006) might be due to differences in norms across social groups (i.e. indigent versus non indigent).

The paradox is that image motivation leads to a crowding *out* of motivation to conserve water in the indigent sub sample, but yet we pick up no significant effect in the lowest income quintiles. Note, indigents exist within the lowest income quintiles, but not all low income households have indigent status: if not automatically granted given their property value, households must prove low income status to the government. Thus we hypothesise three potential channels driving this result: indigents receive subsidised (or free provision of) utilities, and thus may not internalise the incentives if they do not look at their monthly utility bill. However, in Chapter 4, we observe that the tariff graph and financial gains inserts lead to a decrease in consumption in the indigent sub sample, whereas the social incentives (social norm, social recognition and public good) lead to an increase in consumption. This would imply the indigents do look at their bills.

The second channel could be that indigents do not internalise the incentive if they feel it is not applicable to them: as part of the right to safe and sufficient water (a constitutionally protected right in South Africa), their indigent status is a signal that they are marginalized and legitimizes the rebate they receive (they are entitled to it). In the case of the social incentives, where there is no financial gain, the household's (justified) feeling of entitlement to a minimum level of consumption likely superseded the social incentive.

A third channel is that this social group assigns different norms to social recognition than the non-indigents (including low income non-indigents). In line with Bénabou and Tirole (2006), public recognition is a noisy signal for this social group and crowds out their motivation. Following Exley's (2014) hypothesis, the strength of the greedy signal might be a determinant of the outcome. We find evidence of this in the income quintile analysis: in the lowest quintile, the indigent sub sample decreases consumption by almost 900 litres only if provided the opt-out.

A significant limitation of this chapter is that some may argue that the treatment for intrinsic motivation is an extrinsic incentive. However, the message is in line with the public campaigns during the drought asking households to reduce their consumption by 10% and written with a neutral framing. There was no direct incentive offered nor punishment threatened if the household succeeded or failed, respectively, to reduce their water consumption. Another critique of the intrinsic motivation treatment is that it could instead be interpreted as a challenge to compete with one's self. We are not aware of studies which test the competition with one's self in relation to conservation behaviour. However, this critique reinforces the motivation behind the treatment: if an individual was not intrinsically motivated to conserve, they would likely not interpret the insert as a challenge to improve their conservation behaviour.

Further research is needed to i) disentangle how many of the "opt outs" were indigents who then saved water, and ii) conduct a sub sample analysis only on indigents to investigate the channels further. We also plan to merge our data with the Census data to look at the interaction of race with image motivation.

In application to public policy, the results suggest that at least in times ofwater scarcity, public recognition incentives can be effective at promoting water conservation amongst the wealthiest households. In a separate working paper (Brick et al., 2016a) we find wealthier households are less responsive to price signals. The price of water is nominal for these households, and thus marginal tariff increases may be less effective at motivating the highest consumers to reduce their water consumption. The finding that non monetary extrinsic incentives are particularly impactful on the middle to upper income groups can be a useful policy tool for those households whose behaviour is difficult to change with price effects alone.

Chapter 6

Conclusion

Conservation often yields higher benefits to society than to the individual. Thus incentive structures for individuals need to be designed in order to achieve socially optimal outcomes. Currently, various monetary incentives are being deployed by multilaterals, governments, municipalities and corporations throughout the world (see Cavelier and Munro Gray (2012)) to galvanize conservation with the expectation that such interventions motivate sustainable consumption of natural resources. Yet, few studies have rigorously tested the impact of monetary and non monetary incentives on behaviour to determine which incentives work and whether they are cost effective.

The central research question of this thesis is "what are the incentives for individuals to conserve the environment: monetary incentives, social incentives, or appealing to one's intrinsic motivation?". A deeper investigation in this thesis seeks to understand i) if individuals have intrinsic motivations to conserve the environment (and if so, how to measure them), and ii) do extrinsic incentives crowd in or out intrinsic motivation, a question which has not yet been sufficiently explored in the economics literature. The questions are informed by theoretical contributions on motivation and incentives by Frey (1992) and Bénabou and Tirole (2006).

This thesis presents empirical evidence on the use of different incentives to promote conservation and provides new empirical evidence on the interaction of incentives and motivation. In this conclusion, I will first summarize the key contributions and limitations of each chapter, potential avenues for future research, and then reflect on contribution of findings in this thesis as well as behavioural economics more generally.

Chapter 2 exploits data from a field experiment in São Paulo, Brazil to analyse the role of extrinsic and intrinsic incentives in shaping individual demand for a Payments for Environmental Services (PES) program. We contribute to the literature by developing a taxonomy of motivations and test whether monetary incentives crowd in or crowd out preexisting intrinsic motivations. Our findings suggest that, in contrast with predictions from rational choice theory, individuals' responses to incentives are not monotonic: demand does not increase with price. When interacting the incentive offer level with preexisting intrinsic motivations, we find proenvironment and prosocial landholders are less likely to accept the incentive, and their refusal increases at higher offer levels. However, results must be taken lightly: if the instrument did not capture the landholders' true willingness to accept (WTA) value, then we cannot adequately measure the interaction of accepting the incentive and motivations.

To the extent that people do have preexiting motivations to conserve, implementation of a PES program might crowd out their conservation behaviour in the long run, whereas if no such motivations existed previously, or the motivations have no effect on participation, then crowding out is unlikely to be an issue. Further research is needed to understand the long run effects of the introduction and implementation of a self-selecting PES program in the community on conservation behaviour for both those who did and did not enroll in the program.

Chapter 3 examines the causality between conservation zones established in the period 2004-2010 and the large reduction in deforestation rates in the Amazon. By combining satellite data on deforestation with data on the location and timing of the conservation zones, we provide spatial regression discontinuity estimates and difference-in-difference estimates indicating that the policy cannot explain the large reduction in deforestation rates. The reason is that the zones are located in areas where agricultural production is likely to be unprofitable. Thus a major limitation of our work is that the zone placement is endogenous. Our findings point to the need for explanations other than the conservation zones to explain the sharp decline in deforestation rates in the Brazilian Amazon since 2004. As most of the decline in deforestation rates in Brazil took place outside rather than inside the zones, a future avenue for research is identifying factors which reduced deforestation in areas outside of conservation zones. We do, however, find supporting evidence that putting municipalities on a "shame" list by the federal government led to a decrease in deforestation rates in zones within those municipalities. The list increases visibility and thus accountability as these municipalities were subject to more rigorous environmental monitoring and law enforcement from Brazil's environmental protection agency.

In Chapters 4 and 5, we design and implement a randomised control trial across 400 000 households in the City of Cape Town, South Africa, to test various non monetary incentives to promote water conservation during drought in a developing country beset by high inequality.

In a context where water conservation must be promoted but the price signal is diluted either because the poor do not pay full price[1], or, because higher income households have a high elasticity of demand, it is pertinent for government to create policy which incentivises households at all income levels, while being low-cost, and non-punitive to the poor.

Similar interventions in developed country settings find an impact of approximately 2%, which the authors attribute to the influence of social norms (Allcott, 2011). Using data on the 400 000 randomised households, we break down the social norms intervention into possible causal channels, and include intrinsic motivation and social recognition treatments. We find social norms has a significant impact on conservation behaviour (1.3%) but its impact is equal to all other treatments with the exception of social recognition, which has an average treatment effect of 2.2%.

[1]To help alleviate financial constraints of the poorest households, the City of Cape Town in the Western Cape province subsidises water and other utilities for those who qualify for the grant.

More importantly, given South Africa's extremely unequal income distribution, we are interested in heterogeneous responses across income groups, which are important for improving cost-effectiveness and understanding the causal mechanisms of the treatment effects (Ferraro and Miranda, 2013). Akin to Maslow's hierarchy of needs, we find lower income households respond only to financial incentives (a 3.3% decrease from their baseline mean) whereas higher income households respond only to social incentives (a 2.6% decrease from their baseline mean).

Critical for South Africa, these incentives are non-punitive and low-cost: the cost - effective estimate is R0.005 (0.0004 USD) per household for the financial treatment and R0.007 (USD 0.0006) per household for the social recognition treatments. These estimates improve to R0.002 and R0.003, respectively, when targeted at the most responsive groups (lower income quintiles for the former, higher income quintiles for the latter).

Our results show that non-pecuniary incentives can promote conservation over and above traditional demand side management tools but need to be adapted appropriately according to income groups. A limitation of our quintile analysis is that the confidence intervals for the estimates are large, so the interpretation of the estimates is not precise. A limitation of our design is that the social recognition and intrinsic motivation treatments provided an explicit target level for which to reduce consumption. However, the 10% target was in line with the City's wide-spread public media campaign. Thus all households were subject to being asked to reduce their consumption by 10%, but our two treatments made the public campaign more salient. Finally a large limitation of the implementation is the inability to measure compliance. We only know if the household was mailed the insert; we do not not know if the household read the insert (and if so, if the reader is the influencer of behaviour in the household and/or bill payer). Nonetheless, we have no reason to postulate that there are systematic differences in the probability of reading the insert across arms of the trial. Thus, we assume random attrition.

In Chapter 5, we tease out the social recognition treatments to analyse if extrinsic incentives - social recognition - crowds out intrinsic motivation[2]. We find both support for and against Bénabou and Tirole's (2006) hypotheses. When exogenously varying the visibility of the "doing good" behaviour, by creating an explicit opt-out in one of the social recognition treatments, we find image motivation - or "compulsory" social recognition - crowds in motivation for the full sample. We find no effect when social recognition is not fully visible. This shows that social approval is key to galvanizing behavioural change. However, the effects are heterogeneous: in contrast to the findings from the average treatment effect, we find that image motivation treatment *increases* consumption in the indigent sub sample, validating Bénabou and Tirole's (2006) hypotheses. Thus appearing on the public list is a noisy signal as it is viewed different by different social groups.

A significant limitation of this chapter is that some may argue that the treatment for intrinsic motivation is an extrinsic incentive. However, the message is in line with the public campaigns during the drought asking households to reduce their consumption by 10% and written with a neutral framing. There was no direct incentive offered nor punishment threatened if the household succeeded or failed, respectively, to reduce their water consumption.

For further research, we will analyse the impact of household names appearing on the City's website to see if behaviour changed - both in the households who opted out and those for whom the recognition was compulsory - as a result of the list existing in public domain. We also intend to merge our data with the Census data to analyse heterogeneity not only across income but also race and changes to dwelling infrastructure over time. Furthermore with access to data on other utilties, we plan to test the assumption that changing behaviour in the water context may have spillovers to other utilities reported on the municipal bill such as electricity usage. We also need to investigate further the results with the indigent group by conducting a separate estimation for this population. Another key avenue for research is

[2]The social recognition treatment in Chapter 4 corresponds to the "image motivation" treatment in 5, where it has the same effect, with the only difference is that in Chapter 4 we pick up more effect on indigents in the lowest quintile.

also whether the intervention improved bill non-payment and amongst which income groups.

While each of the studies within this thesis are internally valid, the results do not have external validity. However, it is important to reflect on the overarching empirical results which are consistent across the chapters. I find monetary incentives are not effective on those with prosocial or proenvironment motivations. This overall finding supports Frey's (1992) hypothesis that monetary incentives may be perceived as an external instrument to regulate intrinsic motivation, which diminishes self determination and thus welfare associated with ecological behaviour. However, while we find monetary incentives undermine proenvironment and prosocial motivations in Chapter 2, monetary incentives are indeed effective in Chapter 4. Yet when we look closer, households who are motivated by social incentives ("prosocial"), or by appeals to the public good, or by their intrinsic motivation to save water ("proenvironment") do *not* respond to the monetary incentive treatment in Chapter 4. Rather only the lower income households respond to the monetary incentive treatment, and these households are not motivated by social incentives nor by appeals to help the environmental crisis.

However, while I find evidence that monetary incentives undermine intrinsic motivations - as in Chapter 2 the landholders are less likely to accept the high levels of the monetary incentive and in Chapter 4 the households do not respond to the incentive - I do not find evidence that it actually *reduces* intrinsic motivation. In Chapter 2, the main limitation is that we cannot observe their behaviour change with regards to conservation practices because we do not have end line data. In Chapter 4, we do not see that the high income households increase their water consumption with the monetary incentive - we only observe that they do not decrease their water consumption. Thus, we can only say monetary incentives are not effective on people with proenvironment and prosocial motivations in these studies.

Non monetary incentives, on the other hand, do not crowd out intrinsic motivation on average and are highly effective across higher income groups. Image motivation vis-á-vis public recognition, as well as appeals to intrinsic motivation and the public good incentivises - on average - a large decrease in water consumption, and this effect is amplified in the higher income quintiles. *However*, they must be applied appropriately: the causal channels through which the non monetary incentives affect behaviour vary across income groups, as non monetary extrinsic incentives do decrease desired conservation behaviour of low income and especially indigent households. We find in Cape Town that, while providing monetary incentives decrease consumption in the lower income quintiles, these households and especially indigent households respond negatively to social incentives by increasing their consumption (social norms, image motivation, appeals to the public good). Thus we find support for and against Bénabou and Tirole's (2006) hypotheses on image motivation crowding out cooperation. Comparing the results of Chapter 5 to Chapter 3, we see that public shaming (or faming) leads to a positive change in behaviour, on average, over and above regulations: the creation of a Federal "shame" list of municipalities with high deforestation led to a decrease in deforestation in those listed municipalities in Chapter 3. Visibility and thus accountability is a key finding from this thesis: whether it's publicly rewarding or shaming, we find recognition can be a highly effective incentive to change environmental behaviour when applied appropriately.

Critically, this thesis explores behavioural theories that deviate from the rational choice model. In each chapter, we see that the rational model does not always hold: in Chapter 2, we assumed that landholders' demand was monotonic in price, yet landholders were less likely to accept higher monetary offers than lower offers. In Chapter 3, we hypothesise zoning regulation caused the decrease in deforestation in Brazil, yet we are not able to attribute the introduction of conservation zoning to the decrease in deforestation. In Chapter 4 and Chapter 5, while we cannot casually measure if tariff hikes and structural adjustments incentivised households to lower their water consumption, we do see a large decrease in water consumption from the year prior in both the treatment and control groups. Yet, we were able to show that low-cost behavioural interventions can cause even greater reduction in water use at the household level on top of existing tariff increases, water restrictions, and public campaigns.

When evaluating the value added from behavioural economics, we first recognise the standard model works well when information is made available and presented well: a key take away is that people respond most strongly when information is understood and made relevant (Chapter 2 and 4). However individuals are also irrational: people respond strongly to social incentives such as shaming (Chapter 3) and faming (Chapter 5). While standard economic policy (i.e. changing the cost-benefit analysis through a change in price, regulation, and/or law) is often necessary, especially for structural issues, policy design should incorporate behavioural economics to account for the psychological processes that make individuals think automatically (using heuristics) and socially (World Bank, 2015). Importantly, behavioural economics offers low-hanging solutions which complement standard economic policy, and, are cost-effective.

The main limitation which permeates throughout the chapters is that there is no one-size-fits-all policy to incentivise conservation at the individual level and across income groups. Human behaviour is complex: individuals are heterogenous in their preferences and make choices under varying constraints. Policy makers should expect to use a toolbox of monetary and non monetary incentives to promote sustainability of resources across different income groups and in different settings. Thus in order to achieve fiscal sustainability while creating equitable policies, policy makers may consider running randomised controlled trial pilots, varying the subsidy levels and/or non monetary incentives and eliciting motivations, to establish potential impact of monetary and non monetary incentives on their population. Such studies, complemented with information campaigns, can be powerful ex ante instruments to improve the design of the policy in times of resource scarcity.

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Appendix A

Appendix to Chapter 2

A.1 Indices

Indices

Proenvironment	If border areas of rivers and springs were recovered with forest,the most important benefit to landowners would be preservation of the environment or improving air quality (over income effects). Burning, dumping of trash, dumping of toxins, deforestation, and damming of their neighbors property will harm the environment. The supply of drinking water will not last forever.
Prosocial	The community and landowners are the most responsible to protect the environment for future generations.
Progovernment	The government is the most responsible entity to pay to protect water resources on private land. The government is the most responsible entity to pay to protect water resources on public land.
Social norms	The respondent plans to discuss the project with his or her neighbor after the survey. The respondent will participate in the program if he or she found out his or her neighbor is participating.
Prolegal	The household is currently already conserving 100 percent of the land under legal APP boundaries.
Access to information	Heard of PES or a similar scheme before Heard of the Mina d' Água project before. Fully understands the APP Forest Code.

A.2 Survey instrument for WTA

Interviewer[1]: Imagine a government project to compensate landowners for protecting water sources as a way to help other water users. This type of program has already been implemented in several countries and in other parts of Brazil. This program is called Payment for Environmental Services. To participate in any government project for Payment for Environmental Services, you must comply with

[1]The instrument is only one section of a seven section baseline survey. I did not design this instrument; rather it was designed by the World Bank team along with other experts who designed the full baseline survey. Please note, the original survey is in Portuguese. The translation is not professional.

environmental legislation. You will need, for example, to stop planting and prevent access to livestock in areas along the banks of rivers and streams and also around the source. These areas are called APP "Areas of Permanent Preservation". In the APPs of rivers, streams and springs, you must plant trees in a strip along the body of water. You, a small landholder, may even have fruit trees or cultivate some other type of product among the native species, under specific norms, in what we call the SAF- Agroforestry System, but can not cut the vegetation or develop activity Extensive range in this range, ranging from 5m to 15m depending on the size of your property.

You will also need to contact the state environmental agency to register your property in the CAR - rural environmental registry. In addition to planting in APP, as previously reported, you must indicate in the CAR the areas of native vegetation that has to be kept as Legal Reserve. The CAR will be mandatory for all rural properties in Brazil and will allow the owner to have access to programs such as PRONAF and various other benefits, including the commercialization of their native vegetation areas.

(Show card with watersheds at various conservation stages)

Interviewer:(Discuss overall problems that these studies have.) Before talking about how you would respond to this type of conservation program, I want to talk about problemS we have in studies like this. People do not always think carefully about how they would actually respond if it were a real conservation program, or just give the answer they think the interviewer wants to hear. But if people do this, the answers will not reflect how they would actually respond to the conservation program, so that it may be poorly designed and probably will not work very well. It is important to understand that in these studies there are no right or wrong answers.

1. Have you ever heard of any such program? (Select one option only)

(i) Yes you have already heard

(ii) Yes you have heard but did not know what it was

(iii) Never heard of it.

2. Would you like to participate in such a program? (Select one option only) (Y/N)

3. Did you know what was an Are of Permanent Preservation was (APP)? (Request the interviewee to explain the main aspect of the law. Do not read options, select which best characterizes their knowledge)

(i) Never heard of

(ii) Know the law

(iii) Know a little

(iv) They say that they know, but they missed or do not know some details

(v) They speak about it, but refer to the previous legislation

(vi) They know the the law

Section I: Conservation and regeneration of native vegetation

1. Imagine a government project that pays a certain amount to save APPs. Considering the actions that you will have to take to participate, would you be interested in participating by receiving R $X per year to conserve one hectare? (Y/N) (If Yes- go to Question 3, if No- go to Question 2)

2.Would you be interested in participating by getting $ X per year to conserve one hectare? (Y/N)

3. Are you sure of your answer? (Y/N)

4. Which of the sentences best represents the reason for you to be willing to receive this amount to conserve the forest in the APP areas?

(i) The guarantee of having enough water for the domestic activities and in the property / house.

(ii) The guarantee of having quality water to give to animals and plants .

(iii) So that my children and grandchildren have enough water to drink, cook, bathe for life

(iv) For the simple fact of finding important the existence of the river or dam, regardless of its current or future use

(v) So you can use the dam or the river as a place of leisure for you and your family;

(vi) I do not know

(vii) Other, specify

5. Why would not you like to receive no money to recover the woods in the APP areas? (Do not read the options, select all that apply)

(i) To keep the area is the obligation of the owner, I should not receive compensation for this

(ii) Conserving one hectare compromises productive areas

(iii) The incentive is low

(iv) Do not trust that this program will be deployed

(v) It is not my responsibility

(vi) Would use the area for other purposes

(vii) I do not need the money

(viii) I do not want anyone to control what I do on my property

(ix) Bureaucracy

(x) I do not have the necessary documents

(xi) I do not know

(xii) Other, specify

Section II: Restoration

1. Imagine another government project that pays value to restore APPs that are not yet covered by forest. Considering the actions you will have to take to restore one hectare of your property and the necessary actions to participate in any government project, would you be interested in participating by receiving a one-time payment of R $X to restore one hectare? (Y/N) (If Yes- go to Question 3, if No- go to Question 2)

2. Would you be interested in participating by receiving a one-time payment of R $ X per hectare? (Y/N)

3. Are you sure of your answer? (Y/N)

4. What is the main reason for you have this provision to receive for the restoration of the forest in the areas of APP? (Just to reinforce the argument ask, if these would be the other reasons)

(i) I would restore anyway

(ii) The payment is good

(iii) Payment is little, but it is an incentive to comply with the law

(iv) The payment is greater than the expenses I will have

(v) I need money

5. Why would you restore it anyway?

(i) Because the area is not productive

(ii) Because I want to fulfill the legal obligation

(iii) Because I want to conserve the water I use

(iv) Because I want to conserve the water that others consume

(v) Other, which:

6. Which of the sentences best represents the reason for you to be willing to receive this amount to recover the forest in the APP areas?

(i) The guarantee of having enough water for the domestic activities and in the property / house

(ii) The guarantee of having quality water to give to animals and plants

(iii) So that my children and grandchildren have secured enough water to drink, cook, bathe for life

(iv) For the simple fact of finding important the existence of the river or dam, regardless of its current or future use

(v) So you can use the dam or the river as a place of leisure for you and your family;

(vi) I do not know

(vii) Other, specify

7. Why would not you like to receive no money to recover the woods in the APP areas? (Do not read the options, select all that apply])

(i) To recover the area is the obligation of the owner, should not receive for this reason

(ii) Recovering a hectare greatly compromises my productive area

(iii) The incentive is low

(iv) Do not trust that this program will be deployed

(v) It is not my responsibility

(vi) Would use the area for other purposes

(vii) Do not need the money

(viii) I do not want anyone to control what I do on my property

(ix) Bureaucracy

(x) I do not have the necessary documents

(xi) Other, specify

(xii) I do not know

Section III: (Show a visual card with different types of watersheds and water quality): The springs are formed from the rainwater that falls in the forest. The water you use on your property comes from this spring. The better the forests around the source the better the quality and quantity of water. The river will have enough water of good quality to supply you and the cities for many decades with reduced consumption and recovery of springs.

1. Knowing this, would you change your mind about not joining the program? (Y/N)

2. If you have free technical assistance available, such as free mapping of your property, you receive the donation of fences for the adequacy to the legislation, the donation of Seedlings, and specialized technical assistance for the development of productive SAFs, would you change your mind about not participating in the program? If yes, which one does it matter most? ((Select one option only))

(i) Yes, mapping

(ii) Yes, hedges

(iii) Yes, seedlings and seeds

(iv) Yes, technical assistance

(v) No

3. If your neighbor participated in this program, would you also participate? (Y/N)

4. Would you talk to your neighbor about this program? (Y/N)

5. How do you characterize your APP?

(i) Completely preserved

(ii) Little preserved

(iii) Partially preserved

(iv) Not preserved

A.3 Frey's (1992) Model on Extrinsic Incentives Crowding out Intrinsic Motivations

Frey (1992) was one of the first economists to introduce this phenomenon into economic theory by proposing a simple rational choice model where individual behaviour, B, is determined not only by external incentives, E, such as prices and regulation, but also by intrinsic motivation, M.

$$B = B(E, M) \tag{A.1}$$

The principal maximises the agent's performance by choosing the appropriate intensity of external instruments:

$$\frac{dB}{dE} = B_E + B_M(\frac{dM}{dE}) = 0 \tag{A.2}$$

Agents increase their utility by applying their intrinsic motivation.[2] Marginal utility is assumed to be decreasing and marginal cost increasing. When the principal varies the intensity of instrument E, the agents adjust the optimal choice of intrinsic motivation according to

$$U_{ME} + U_{MM}\frac{dM}{dE} = 0 \tag{A.3}$$

Whereby the sign of dM/dE is determined by U_{ME}, that is, the effect of the external instrument on the marginal utility of acting through intrinsic motivation. The principal takes this motivational adjustment into account when the intensity of the instrument is chosen:

$$\frac{dB}{dE} = B_E + B_M(\frac{U_{ME}}{-U_{MM}}) = 0 \tag{A.4}$$

When U_{ME} >0, the instrument raises the marginal utility of exerting intrinsic motivation, thus a "crowding-in" effect, versus when U_{ME} <0, the instrument is damaging the marginal utility of intrinsic motivation and is thus "crowding-out". The principal choses to apply the instrument, and at what intensity, or not, depending on the outcome.

But how is U_{ME} determined? Frey (1992) draws on psychology literature (Deci and Ryan, 1985) to discern two conditions that diminish or increase marginal utility of intrinsic motivation - self-determination and self-evaluation. U_{ME} is reduced when the individual perceives that the external instrument is used to control or regulate the individual's intrinsic motivation. It is then said to diminish their $self-determination$. Alternatively, U_{ME} increases if the external instrument is interpreted as a recognition by the principal that the agent is exercising their intrinsic motivation in the task, which is seen as raising their $self-evaluation$.

Frey states that a prize given for good performance supports intrinsic motivation, so long as it is not seen as a direct substitution for monetary payments nor is regularly given, while a monetary reward is usually interpreted as a sign that the principal does not acknowledge the efforts arising from intrinsic motivation (Frey, 1992). However, Frey contradicts himself by suggesting that in an application to environmental policy, subsidies support the marginal utility of acting intrinsically in favor of the environment because the agent's ethical behaviour is acknowledged and their self-determination is not challenged.

The result is dependent on how the agent perceives the incentive. If the gift or monetary reward is given for something the agent considers to be within terms of contract, or if its interpreted as an effort to externally control self-determination and intrinsic motivation then U_{ME} will diminish. In terms of self-evaluation, if the principal gives the impression that they do not recognise that the agent exercises intrinsic motivation in the task, it is worth less to the agent. Therefore, it is important to understand individual's perceptions in a PES scheme to understand if it

[2]Initial level of intrinsic motivation is assumed to exogenously given

may crowd-out intrinsic motivation.

Appendix B

Second Appendix to Chapter 2: Do They Do As They Say? Stated versus Revealed Preferences and Take Up in an Incentives for Conservation Program in an Incentives for Conservation Program

B.1 Introduction

Conditional cash transfer (CCT) programs have become common in development policy due to their success in boosting health and education outcomes (see, among others: Fiszbein et al. (2009); Gertler (2004); Skoufias et al. (2001)). Payments for Environmental Services (PES) are similar in concept, offering cash payments for conservation (Ferraro and Kiss, 2002; Wunder, 2005; Pagiola and Platais, 2007; Engel et al., 2008; Wunder, 2008). PES is subject to the same question as CCTs, namely: do such programs actually motivate people to change their behaviour? Due to the self-selection nature of many incentive programs, there is a risk that the incentives go to those who already comply with the program's conditions, thus limiting the program's additional conservation impact on the environment ("additionality"). Despite an increased use of PES in the field, the analysis of such programs have received less attention in the economics literature than other types of CCTs (Pattanayak et al., 2010). The impact of these programs has significant fiscal and environmental implications, which are relevant for policy making.

Of the few impact evaluations of PES programs that have been conducted to date, the results are mixed. While some programs have had high impacts (Alix-Garcia et al., 2015; Pagiola and Rios, 2013; Pagiola et al., 2016; Arriagada et al., 2012), others appear to have had limited impacts (Ferraro and Pattanayak, 2006; Robalino and Pfaff, 2013). In cases where the impact has been limited, the hypothesised mechanisms are (i) low or no additional conservation ("additionality") because participating landholders would have conserved their land even in the absence of the incentive program (Sierra and Russman, 2006; Sills et al., 2008; Robalino and Pfaff, 2013); and, (ii), “slippage” or “spillovers”, whereby deforestation is diverted to areas not covered by the program (Alix-Garcia et al., 2012).[1]

An additional explanation for low conservation impact - which is yet untested - is that offering payments for conservation might undermine intrinsic motivations to conserve. This question can be divided into two: (i) whether landholders in fact have intrinsic motivations to conserve, the basis for these motivations, and if these motivations drive participation in PES programs; and (ii) whether participation in PES programs undermines or supports these motivations. In this paper, we use data from a PES program being implemented in São Paulo, Brazil to examine the first of these questions (examining the second will require waiting for the project to be completed in order to collect end line data). The program's objective is to preserve and improve the water quality by incentivizing upstream landholders to maintain and/or recover trees surrounding springs on their private property in critical watershed areas which are already protected under the Brazil Forest Code. Thus, the payments are an incentive to comply with the law. Payments will be made annually over a three year renewable term and land is monitored through annual field visits (see Section B.2 for more on the program).

In principle, PES seeks to change the land use behaviour of land degrading property owners for the benefit of the community. The assumption behind PES is that intrinsic motivations are less important than economic incentives in determining behaviour. However, the effect of a payment on behaviour may vary across individuals depending on their pre existing intrinsic motivations and what triggers those motivations. Insights from Self-Determination Theory (SDT) suggest that the outcome is dependent on how payments satisfy not only the landholder's need for profit but also his need for purpose and self-satisfaction (Deci and Ryan, 1991; Ryan and Deci, 2000). Specifically, the decrease or increase in intrinsic motivation is due to three psychological factors: how the incentive affects the need to feel *competent*, the need to be *self-determined*, and the need to feel *connected* to others. Ezzine-de Blas et al. (2015) extend SDT to also include the need to feel connected to the environment. Depending on how the incentive triggers these psychological factors, the incentive may feel imposed on the individual and result in a crowding out of their motivation; or alternatively, the incentive may be internalised if it triggers self-satisfaction and crowds in their motivation. The outcome may determine whether the landholder enrolls in the program.

The assumption behind the crowding out literature is that individuals (i) have pre existing intrinsic motivations and (ii) these motivations can be triggered by an external incentive. If we assume PES contract designers have asymmetric information, then gathering information on pre existing motivations of potential PES recipients may better inform the principal prior to both parties signing the contract. Landholders who are *already* intrinsically motivated to conserve according to program conditions may not be the preferred participants in a PES program if the program goals are cost-effectiveness and high additionality. Furthermore, to determine if landholders not yet conserving their land are incentivised by the introduction of payments, an analysis of how motivations interact with the incentive might help explain take up patterns which can be used for program targeting to

[1] There are also concerns that impacts may not be permanent (Pagiola et al., 2016). Lack of permanence would not affect results at the end of the program, however.

achieve additional conservation.

The intention of capturing intrinsic motivations is grounded in the hypothesis that PES program take-up is not fully explained by observable proxies for opportunity costs. Thus by capturing and measuring motivations, we can obtain more information on the landholders. We can use this information to test the mechanisms through which intrinsic motivations interact with an incentive to participate in a conservation program.

However, intrinsic motivations are latent and thus difficult to measure. This paper contributes to the literature on incentives and motivation in the context of PES program take up by providing tools to understand how to disentangle and measure latent motivations; by testing the validity of the measured latent motivations on revealed preferences of conservation; and by using the latent motivations to analyse determinates of take up for a PES program.

behavioural analysis using survey responses relies on *stated preferences*, which may or may not correspond to *revealed preferences* (for example, see Nolan et al. (2008)). In the baseline survey for the PES program, we capture stated preferences through an exhaustive survey asking questions on the role of society and individuals with respect to the environment. We conduct factor analysis on these stated preferences to elicit latent motivations, which include proenvironment, prosocial, progovernment and social norms. We use these latent motivations as the "stated preferences" in this paper.

To overcome the weaknesses inherent in the analysis of stated preferences, we also measure revealed preferences by documenting the pre existing level of conservation on each hectare of property at the time of the baseline survey. We then use this data to first examine the role of motivations as a determinant of conservation behaviour by studying if the indices constructed from the stated preferences predict revealed preferences, as captured by observed conservation behaviour.

We hypothesise that landholders with proenvironment motivations will already be conserving land that is not under legal protection,[2] controlling for observable opportunity costs. Confirming these assumptions, we find that proenvironment and prosocial landholders are significantly more likely to conserve land not under legal protection before the program is introduced when controlling for a comprehensive set of demographic, socio economic and land characteristics.

With validation that the stated preferences in our sample capture intrinsic motivations, we explore the extent to which the interaction of these motivations with a monetary incentive affects participation in the PES program. We find that proenvironment landholders are more likely to participate in the program. Social norm and prosocial motivated landholders, on the other hand, are less likely to participate.

Bridging the stated preference analysis with the take up analysis, we find prosocial landholders and proenvironment landholders are more likely to be conserving private land *outside* of legal protection, but only prosocial landholders are more likely to be already conserving land *under* legal protection before the introduction of the payments program. The finding that proenvironment landholders are then more likely to enroll in the program demonstrates that offering an incentive to those close to the margin of conserving land within legal protection helps to crowd in

[2]"Legal protection" refers to land demarcated as "Areas of Permanent Protection" (APPs), which requires 100 percent conservation. In the case of springs, the permanent forest preservation areas (APP) consist of a 50 m radius from the center of the spring.

intrinsically motivated landholders. These landholders are the preferred recipients as opposed to prosocial landholders whose enrollment would not result in additional conservation. However, to achieve high additionality, program administrators would benefit most if those with high opportunity costs were motivated by the incentive; we find these landholders are in fact less likely to enroll in the program. We discuss all findings in light of the SDT theoretical framework.

The rest of the paper is structured as follows: Section B.2 describes the context and Section B.3 describes the data collection; Section B.4 discusses the construction of stated preference indices; Section B.5 describes the estimation strategy; Section B.6 discusses the results; and Section B.7 concludes. The main regressions can be found at the end of the paper in Section B.8.

B.2 Context

The Mina d'Água (MdA) pilot program is being implemented in 21 municipalities, one in each of São Paulo's Hydrographic Water Management Units (UGRHI) (von Glehn et al., 2012). All participating municipalities have a legal framework that allows payments to landholders for environmental services. This is the first PES pilot implemented directly by the São Paulo state government. It falls under the state policy on climate change adaptation and mitigation.[3]

The objective of the MdA program is to preserve and improve the water quality by incentivizing upstream landholders to maintain and/or recover trees surrounding springs on their private property in critical watershed areas. These areas are already protected by the Brazil Forest Code, and are referred to as Areas of Permanent Protection (henceforth "APPs" or "within legal protection"). Hence the payments are an incentive to comply with the existing law. However, in addition to conserving 100 percent of land demarcated by the government, the full Brazil Forest Code also obliges the landholder to conserve 20 percent of land outside of demarcated areas. The MdA program does not impose the second requirement of the full Brazil Forest Code.

[3] An earlier pilot was implemented in collaboration with The Nature Conservancy (Padovezi et al., 2012).

Figure B.1: Location of the Mina d'Água pilots in São Paulo, Brazil

Priority watershed areas for conservation and restoration are defined as those watersheds that drain to the intakes of local water companies. The project will pay landholders for sustainable land use practices that protect or regenerate forest coverage in a 50m radius around these critical water springs. As mentioned, the PES program does not require any additional conservation and/or restoration. Payments are for up to four springs per landholder and can range from R$74-R$300 per year per spring. The payments are based on a formula that weights the volume of water from the spring, its location, and the degree of conservation. It requires a change in behaviour, unless landholders are already conserving their springs, and potentially a loss of income depending on their current land use practices.

B.3 Data collection

A baseline survey was carried out in two of the 21 participating municipalities, Guapiara and Ibiúna. It covered all potential participants (landholders with springs in the priority areas) as well as landholders in areas adjacent to the priority areas who were surveyed as controls for a future end line evaluation of the Mina d'Água program. Data was collected on the landholder's demographics, socio economic characteristics, characteristics of each individual plot on their property, cultivation and pasture practices, costs and revenues of land use, characteristics of the water springs on their property, willingness to accept compensation for conservation or restoration, and perceptions on the environment. Figures B.8 - B.10 in the Appendix to this chapter (page 220) illustrate conditions at the Guapiara study site.

We carry out the revealed preferences analysis of conservation (Models 1 and 2, described in the next section) using the total pooled survey sample of 350 households. This comprised of households eligible for the program (211 households) and ineligible households (140 households). We then use the sub level data on eligible households (211 households) to study take up of the program[4]. In total 107 out of the 211 eligible households enrolled in the program.

The average age of landholders responsible for agricultural activities is 55 years, and most landholders live on the property. On average, the landholders have two springs on their property, and over 75 percent of the forest on the property is within APP boundaries. The landholders generally use the springs for both family and livestock consumption. Most landholders do not use credit; the majority indicated that they did not need it, and did not select potential reasons for not using credit (such as lack of access, lack of a guarantor, fear of debt, bureaucracy, or failed payments on other loans). Thus we are likely analyzing a sample population that is either not credit constrained or not undertaking investments.

Balance tests compared landholders who enrolled in the program to those who chose not to enroll (see Table B.5 in the Appendix to this paper on page 222). The two groups are generally similar: the average property size is 12 ha, with an average of two agricultural workers. The proportion of steep land in properties in each group is high (77 percent). Approximately 80 percent use land primarily for agriculture. Landholders who did not enroll are currently conserving 71 percent of APP land and 33 percent of non-APP land, while those who enrolled conserve 77 percent of APP and 38 percent of non-APP land.

T-tests of means were used to compare landholders from Guapiara and Ibiúna. When comparing descriptive statistics disaggregated at the municipal level, we see significant differences in multiple variables. Therefore, we cluster the standard errors at the municipal level and use municipality fixed effects in all regressions (see Tables B.8, B.9, B.10 in the Appendix on page 224).

B.4 Capturing Motivations

The strength of the baseline survey lies in the exhaustive list of questions on perception of the environment and society's role in protecting the environment. While we acknowledge that there is a large strand of existing literature on survey methodology to capture proenvironment attitudes (see Clark et al. (2003)), we adopted our questions from a previous survey developed by the São Paulo State Secretariat of Environment (SMA) to ensure compatibility with SMA's surveys in other municipalities. The customised set of questions for participants were context-driven and thus relate directly to the water quantity and quality supply issues in the region[5].

B.4.1 Proenvironment motivation

Proenvironment landholders are those who are intrinsically motivated to protect the environment. As a partial proxy to capture this motivation, we explored responses

[4] During the rollout of the project, all farmers within the priority areas with at least one spring were visited by the municipal implementing agency. Extensive information was provided regarding eligibility criteria, conditions and general compensation during these visits. Conversion from interested farmers into project participants likely suffers from some degree of non-random attrition due to misunderstanding of the conditions and benefits. Similar to analysis of potential take-up between control and treatment areas we analyse the intent-to-treat households (those eligible who expressed interest).

[5] Please contact the authors for the full survey.

to questions on whether they believed land degrading activities of their neighbor cause environmental harm (see Table B.2 for a set of preference questions). We further queried landholders on their perception on the long term supply of water. We asked if landholders believed there were any benefits to restoration and, if so, what they were (see Figure B.2). Improvements in the quality and supply of water were most commonly identified as the largest benefit of restoration. However, strong heterogeneity of beliefs exists in the sample, as the second most popular response was "no benefits".

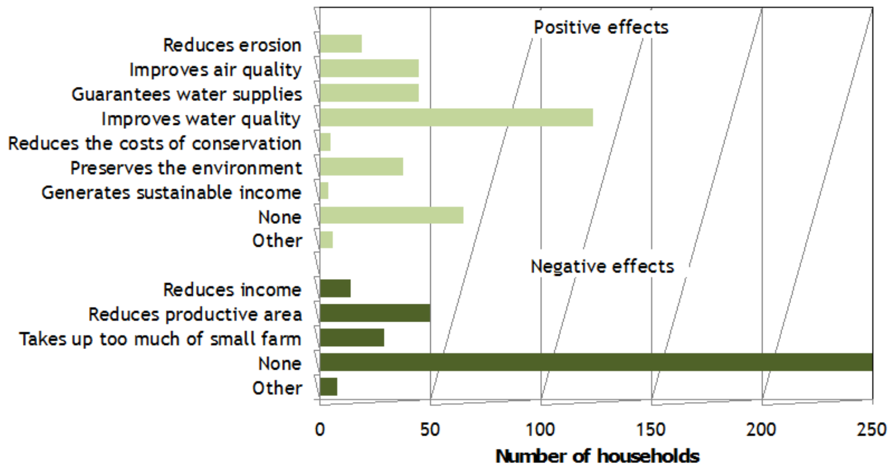


Figure B.2: Perceived benefits and costs of restoration

B.4.2 Prosocial Motivation

We asked respondents who is responsible for protecting the environment for future generations. "Everybody" was the most frequent response, which conveys a strong sense of community-driven protection and social connection as defined in SDT (Figure B.3). Multiple questions were also asked regarding who is responsible to protect and pay to protect water resources on private and public land (see Tables B.6 and B.7 in the Appendix).

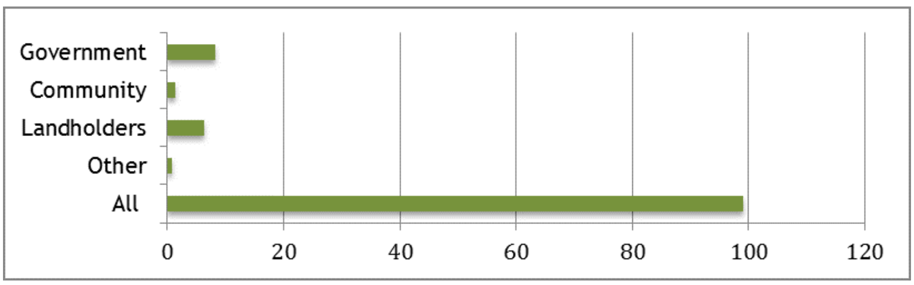


Figure B.3: Household perceptions of responsibility to protect the environment for future generations

B.4.3 Social norm indicators

Social norms differ from prosocial motivations in that the landholder gives weight to the enrollment decision of their neighbors when making their participation decision.

This preference may also be viewed as a collective action motivation. In the survey, landholders were asked whether they would change their decision to enroll in the program if they discovered their neighbors had enrolled. Most responded "No." Another question asked whether landholders planned to discuss this particular project with their neighbors after the survey before making their decision. The majority responded that they would do so, highlighting the importance of peer effects in the community (see Figure B.4).

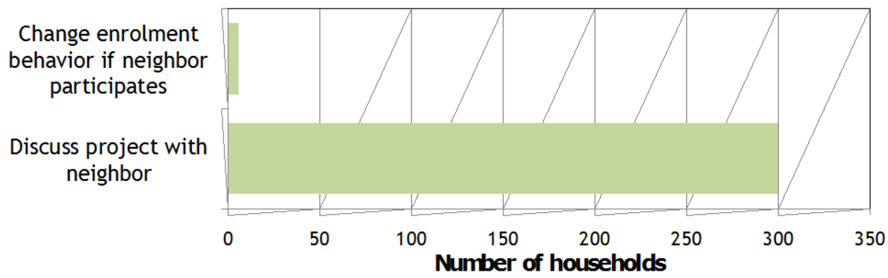


Figure B.4: Effects of neighbors

B.4.4 Mechanisms Driving Take Up

In the conceptual framework detailed in Ezzine-de Blas et al. (2015), the authors use SDT to explain the channels through which changes in motivations are caused by the introduction of PES. We attribute the four psychological factors outlined in their paper to the intrinsic motivations of interest in this paper, as shown in Table B.1.

Table B.1: Effect of PES incentive on landholder's need satisfaction

Intrinsic Motivation	Psychological moderators triggered	Hypothesized channel of how the landholder's needs satisfaction are modified by a PES incentive
Prosocial	Social connection	If the community values conservation irrespective of payment, the payments modify the needs satisfaction by increasing the quality of the landholders' relations with others in the community. The incentive may have a reverse effect, however, if accepting a payment for conservation is against social norms in the community.
	Self-determination	The incentive may support self-determination if landholders are acting in accordance with their free will to conserve the environment. The incentive may decrease self-determination if compensation is viewed as a control mechanism.
Proenvironment	Environmental connection	The incentive may reward the desire to interact and connect with the environment.
	Self-determination	The incentive may support self-determination if landholders are acting in accordance with their free will to conserve the environment. The incentive may decrease self-determination if compensation is viewed as a control mechanism.
	Competence	The incentive may enhance competence if the incentive is interpreted as positive feedback on landholders' existing conservation behavior. Alternatively, it may undermine competence if landholders interpret the incentive as a tool the government finds necessary to increase its existing conservation efforts.
Progovernment	Self-determination	The incentive may enhance self-determination if land conservation is in accordance with their free will and landholders willingly accept compensation from the government.

	Competence	The incentive may enhance competence if landholders believe the government is rewarding them for their ability to achieve positive environmental outcomes (conservation).
Social norms	Social connection	The landholders' participation decision is dependent on their valuation of how conservation behavior, and how accepting a monetary reward in return for positive conservation outcomes, is judged by their community.
Information	Self-determination	The incentive may enhance self-determination through the channel of self-development by learning the legal requirements and context. Their participation decision is based on their own intrinsic valuation of costs and benefits.

Notes: a. Although not an "intrinsic motivation", we consider access to full information outside of the strict rational choice model of decision making.

B.4.5 Constructing indices

As there are less than 350 observations, we reduce the dimensionality of the explanatory variables by creating indices that capture the various motivations of interest.

We consider landholders as having intrinsic motivations: prosocial, proenvironment, progovernment, and social norms.[6] The focus on these motivations is driven by the desire to disentangle social preferences and understand the main intrinsic drivers of PES uptake.

We create composite indices to capture latent preferences. We hypothesise that sets of variables in the baseline survey capture the different motivations. Each index was created by first taking all variables from the baseline survey that could possibly measure the preference and perform factor analysis on them, otherwise known as latent variable analysis[7]. Specifically we hypothesise that separate groups of variables capture: (i) preferences for protecting the environment (protecting the environment from current land degrading activities, the costs and benefits of restoration, and protecting the environment for future generations); (ii) preferences for who is responsible to protect and pay to protect water sources on public and private property; (iii) attitudes towards the government's role in environmental protection; and (iv) social norms in the community.

In order to test our hypotheses, we use confirmatory factor analysis as opposed to exploratory factor analysis, the former of which is used when the researchers have a pre-defined idea of the structure on a set of variables they want to test. After taking the groups of variables we assume to capture the latent motivations, we first perform factor analysis and then rotate the factors using the default varimax rotation to produce orthogonal factors. Where correlations were high, we used oblique rotations of the factor dimensions. We follow the Kaiser Rule, whereby we retain factors with an eigenvalue cut-off of 1. If there are multiple factors with an eigenvalue higher than 1, then the set of variables are measuring not just one latent motivation, but multiple dimensions of the latent motivation. Please refer to the main factor analysis presented in Table B.2. All other factor analyses are included

[6]These categories are not necessarily mutually exclusive. However, we tested equality constraints to determine if the motivations have equal effects on the outcomes of interest. We reject that the parameters are equal.

[7]This method analyses observed variation and covariation among observed variables. We used the unbiased Barlett method rather than the default regression method for the purposes of a smaller MSE.

in the Appendix (see tables B.6 and B.7 in the Appendix).

Taking the factors with an eigenvalue greater than 1, we used the variables which had high factor loadings in the expected direction (see shaded factor loadings in Table B.2). We then chose to aggregate by summing the variables with high factor loadings and standardizing the composite variable to mean 0, standard deviation of 1 to create the indices.

In total, three factor analyses were conducted after systematically reviewing the survey to include all questions that could potentially reflect the motivations of interest. The main factor analysis used to create the latent motivations used in the quantitative analysis - shown in Table B.2 - has multiple factors with eigenvalues higher than 1. Pairwise correlations were all under 20% for the indices created by the main factor analysis and thus we chose to include each of them in the regressions as they represent unique latent motivations. However, we observe high correlations when we compare them against the indices created by the remaining two factor analyses (see Tables B.6 and B.7 in the Appendix). For example, "prosocial" is highly correlated *(=0.97)* with the index created from the second factor analysis (B.6 in the Appendix). F-tests and likelihood ratio tests conclude us to restrict our model to include only "prosocial". When we include the index from the third factor analysis, f-tests and likelihood ratio tests force us to restrict our model to include only the "Progovernment" index. Thus we only use the main factor analysis. The questions used to create the indices are included in Table B.2.

The following non-factored indices were constructed by adding dichotomous variables (0/1) and then standardizing the index with a mean 0 and standard deviation of 1:

Social norms	*The respondent plans to discuss the project with their neighbor after the survey.*
	The respondent would participate in the program if they found out their neighbor is participating.
Informed	*Heard of PES or a similar scheme before.*
	Heard of the Mina d'Água project before.
	Fully understands the APP Forest Code.

Table B.2: Factor Analysis I (rotated factors)

Responses to survey questions	Factor 1 Proenv 1	Factor 2 Prosocial	Factor 3 Proenv 2	Factor 4 Progovt
Recovering areas around rivers and springs with forest using public resources would:				
Improve water quality	0.043	0.023	-0.113	-0.293
Conserve the environment	0.080	-0.023	0.036	-0.028
Improve air quality	0.011	-0.019	0.087	0.991
Improve air quality and conserve environment	0.068	-0.031	0.095	0.760
Improve the environment	0.077	0.002	0.097	0.200
Forest surrounding springs is very important for water quality and quantity	0.005	-0.216	0.078	0.121
Deforestation by your neighbor causes harm	0.053	0.011	0.485	0.042
Damming by your neighbor causes harm	0.081	-0.056	0.825	0.112
Trash disposal by your neighbor causes harm	0.006	-0.137	0.269	-0.052
Use of toxins by your neighbor causes harm	0.064	-0.003	0.327	-0.002
Burning land by your neighbor causes harm	-0.006	-0.075	0.261	0.040
All of the above does harm	0.051	-0.016	0.860	0.106
Water supplies (whether considered abundant, sufficient, or insufficient):				
Will not diminish	-0.997	0.035	-0.044	-0.021
Will diminish	0.997	-0.035	0.044	0.021
Recovering areas around rivers and springs with forest using public resources would have no negative effects for landowners	0.015	-0.048	0.094	0.124
Understands Brazil's Forest Code and APPs	0.063	-0.047	0.071	0.077
Landholder is highly educated	-0.043	-0.074	0.022	0.036
Responsible for protecting the environment for future generations lies with:				
Community, landholders, or everybody	0.061	0.085	-0.024	-0.018
Landholders only	-0.048	0.989	-0.024	-0.014
The community only	0.034	0.105	-0.005	-0.021
Community and landholders	-0.028	0.947	-0.024	-0.022
Responsible for protecting water sources in public areas: Community	0.008	-0.048	0.093	-0.081
Eigenvalue	**2.035**	**1.985**	**1.980**	**1.762**
Proportion of Variance	**0.161**	**0.157**	**0.156**	**0.139**

Notes: Pro Env 1: Concerned about future supply of water; Pro-Social: Concerned for future generations; Pro Env 2: Concerned about negative impacts of land degrading activities; Pro-Govt: Favors public financed restoration
Shaded cells show within each factor, those with high factor loadings in the same direction, and thus included in an index together.

We might be interested in how intrinsic motivations are related to observable characteristics. While observed baseline conservation and proxies for opportunity costs are crucial for understanding take up, these observables fall short in capturing all of the noise in the underlying drivers of take up. By also measuring intrinsic motivations, we aim to explain more of the mechanisms in addition to proxies for opportunity costs. Thus, we should observe very low correlation between our intrinsic motivations and the observable characteristics of the landholders, as observed in Table B.3.

Table B.3: Correlation between latent motivation and demographic variables

Demographic variable	Proenv I: Concerned about future supply of water	Prosocial: Concerned for future generations	Proenv II: Concern about negative impacts on env	Progov: Public financed restoration	Social norms (std)	Informed on PES (std)
Household size	-0.04	0.01	0.06	-0.11	0	-0.09
Gender of household head (1=male)	0.02	0.1	-0.04	0	-0.1	-0.05
Age of household head	-0.07	0.08	-0.06	-0.02	-0.12	0.02
Education level of household head	0.01	-0.06	0.13	0.11	0.05	0
Household income from agriculture	0.03	-0.07	0.03	0.03	0.08	0.09
If household uses credit	-0.09	0.01	-0.1	0.07	0.08	0.09
Profit (in logs)	-0.05	0.03	0.02	0.02	-0.03	0.03
Last yr income not typical (earned less)	0.02	0.05	-0.11	-0.07	0.05	-0.06
Area of property (in ha)	-0.11	-0.01	-0.07	0.06	0.01	0.07
Number of agricultural workers	0	0.04	-0.09	-0.11	-0.05	0.06
Possess legal documents[8]	0	0.05	-0.11	0.02	-0.01	0.09
Land type: Clay	-0.05	0.08	0	0.07	0.02	-0.26
Land type: Sand	0.03	-0.02	0.1	0.01	-0.04	0.07
Land type: Clay-Sand	-0.04	0.04	-0.06	-0.08	0.06	0.03
Land type: Terra Roxa	-0.04	0.03	-0.11	0.03	-0.08	0.06
Proportion of steep land in total property	-0.16	0.04	-0.11	-0.11	-0.02	-0.05
Number of properties eroded	-0.02	0.06	-0.06	-0.02	-0.13	-0.06
Land used for agriculture	0.07	0.1	-0.09	0.01	-0.07	0.15
Area of APPs conserved with trees	-0.05	0.05	0.03	0.05	-0.11	-0.01
Area of non APPs conserved with trees	0.15	0.03	0.1	-0.06	0.02	-0.07

To verify the indices are also independent of each other, Table B.4 displays the correlation matrix of the indices measuring the latent motivations.

Table B.4: Correlation matrix of indices

	Proenv I	Prosocial	Proenv II	Progovt	Social norms (std)	Informed on PES (std)
Pro Env I	1					
Pro-Social	-0.0744	1				
Pro Env II	0.1068	-0.0955	1			
Pro-Govt	0.1175	-0.0478	0.2034	1		
Social norms (std)	0.0926	-0.2174	0.0918	0.0907	1	
Informed on PES (std)	-0.0561	-0.0258	-0.0564	0.0093	0.0133	1

B.5 Estimation strategy

As described earlier, we use a two-step method for our quantitative analysis. First we estimate if stated preferences, measured by factor analysis, predict revealed preferences of conservation behaviour on land *under* legal protection (Model 1) and conservation behaviour on land not under, or *outside,* legal protection (Model 2). Then with validation that the indices predict conservation behaviour, we use the indices to explain PES program take up when controlling for a set of observable proxies for opportunity costs (Model 3).

B.5.1 Stated versus Revealed Preferences model

First we test if the stated preferences as captured by the indices predict revealed preferences as reflected in the level of existing conservation on the property at the time of the baseline survey. The hypothesis is that those with proenvironment and prosocial motivations will already be conserving land that is *not* under legal protection, controlling for observable proxies for opportunity costs as explained below. Conservation is specified as the amount of forest cover both within APPs, and as a separate outcome variable, on the remainder of the landholder's property outside of APPs (Table B.8 and B.9 in Appendix).

The starting point is strict *homo economicus* landholders. In line with the expectations of rational choice models of behaviour, these landholders conserve only if the net benefit of doing so is positive, taking into account the opportunity cost of foregone revenue from alternative uses of the land.

Proxies for opportunity cost controls are captured by the $SocioEconomics_i'$ and $LandCharacteristics_i'$ vectors. We define these as observable opportunity costs because from a landholder's point of view, the quality of their land, inputs and income determine their willingness to accept the incentive for the program.[9] Conservation beyond the expected level of a strict *homo economicus* landholder suggests the individual may hold attitudes that lead him or her to conserve some portion of land

[8] Holds a certificate of registration and/or ownership document

[9] Income may correlate with unobserved factors, such risk and time preference as well as intellectual ability and competence. If this were the case, then the variable income would capture the joint effect of opportunity cost and these unobserved factors on conservation and program participation decisions.

irrespective of costs and benefits. The remaining vectors capture these attitudes.

$$\begin{aligned} PercentAPPConserved_{i,t=0} = \alpha &+ \beta_1.SocioEconomics'_i \\ &+ \beta_2.LandCharacteristics'_i + \beta_3.ProEnv'_i \\ &+ \beta_4.ProSocial'_i + \beta_5.ProGovt'_i \\ &+ \beta_6.SocialNorms'_i + \beta_7.Informed'_i + \varepsilon_i \end{aligned} \tag{1}$$

and;

$$\begin{aligned} PercentNonAPPConserved_{i,t=0} = \alpha &+ \beta_1.SocioEconomics'_i \\ &+ \beta_2.LandCharacteristics'_i \\ &+ \beta_3.ProEnv'_i + \beta_4.ProSocial'_i \\ &+ \beta_5.ProGovt'_i + \beta_6.SocialNorms'_i \\ &+ \beta_7.Informed'_i + \varepsilon_i \end{aligned} \tag{2}$$

Where i is household at time=0 (baseline survey). As the outcome variable in both equations is a proportion, we used a generalised linear model (GLM) with a logit link and the binomial family. Standard errors are clustered at the municipality level, as t-tests indicate significant differences in means (see Appendix). Standard errors are bootstrapped with 1000 replications.

$SocioEconomics'_i$ is a vector of covariates conventionally used in PES take up analysis and include education, age, and gender of the head landholder, total income and (log) profits from agriculture[10], credit access and use, and if last year was typical (and if not, if the landholder earned less or more income). These variables are critical for assessing opportunity cost; if the landholder has significant profits from agriculture, they may be less likely to enroll in a PES program unless the payments for the program are higher than their profits from land use. Information on credit access and use are helpful to understand if people have the ability or willingness to take investments on their land. Alternatively, if they are credit constrained they may need a conditional cash transfer program to overcome investments needed for conservation/restoration.

$LandCharacteristics'_i$ is a vector of covariates including the size of property in hectares, number of people working on the land, possession of required legal documents for ownership or renting of the property, soil characteristics (sand, clay, mix, red soil), steepness of land (proportion of property with steep parcels), evidence of erosion on property, number of springs on property, and if the property is used for agriculture. Included are also variables regarding the landholder's plans to deforest their land or the trees around the spring. Although it is an empirical question, if the landholder has more land, and more workers on the land, we may expect them to be more willing diversify land use and to enroll part of their property in a PES program compared to a smaller landholder who may not have the ability to diversify their land use. As this depends on the motivations of the landholder, we will observe the effects when including motivations as independent variables (see below). Those with property rights that are well defined may be more likely to invest and take care of their land. If the land suffers from high erosion, the landholder may be more willing

[10] Parameter tests and likelihood ratio tests lead us to restrict our model to two proxies for income (income shock last year and credit use).

to participate in a restoration program. Furthermore, flatter land is expected to be more productive so conserving it would entail higher opportunity costs.

$ProEnvironment_i'$, $ProSocial_i'$, $ProGovt_i'$, and $SocialNorms_i'$ and $Informed_i'$ are as defined in the previous section.

B.5.2 Participation model

We estimate landholder-level probit regressions (Table B.10 in Appendix) where the dependent variable Y_i is a dichotomous variable equal to 1 if landholder i enrolled in the PES program, and 0 if not. Municipality fixed effects are included. Marginal effects are computed for continuous and dichotomous explanatory variables.

$$\begin{aligned} Participate_i = \alpha &+ \beta_1.SocioEconomics_i' \\ &+ \beta_2.LandCharacteristics_i' + \beta_3.ProEnv_i' \\ &+ \beta_4.ProSocial_i' + \beta_5.ProGovt_i' \\ &+ \beta_6.SocialNorms_i' + \beta_7.Informed_i' + \varepsilon_i \end{aligned} \tag{3}$$

Vectors $SocioEconomic_i$, $LandCharacteristics_i$,$ProEnvironment_i$, $ProSocial_i$, $ProGovt_i$, and $SocialNorms_i$ and $Informed_i$ remain.

B.6 Results

B.6.1 Stated versus Revealed Preferences (Models 1 and 2)

Opportunity costs

Observable opportunity costs are predictive of conservation behaviour on land under legal protection (within APPs). As the total area of property in hectares increases, conservation of APPs increases by 2 percent (Table B.8). Landholders have more land to divert their land use activities outside of the APPs. Further, as the total number of properties eroded increases by one, conservation of APPs increases by 27 percent.

As we might expect, opportunity costs are more strongly predictive of conservation behaviour on land outside of legal protection. If the land is mostly used for agriculture, conservation outside APPs decreases by 68 percent (Table B.9). As the number of agricultural workers on the property increase by one, conservation of land outside of APPs decreases by 10 percent. We see strong negative associations when analyzing income dynamics: conservation outside APPs decreases by 25-27 percent if the landholder experienced an income shock in the year prior and earned less income than usual. However, forest cover changes slowly. One would not expect forest cover to respond to short-term fluctuations, so the size of this impact in correlations is surprising.

Motivations

In pairwise correlations, the percent of APP conserved is not highly correlated with the percent of non-APP area conserved (12 percent). Thus we may assume different motivations are at play for choosing to conserve land under legal protection versus land outside of legal protection.

Prosocial landholders - those who are concerned about protecting the environment for future generations - are more likely to conserve land both within and outside legal protection. In both regressions, when controlling for proxies for opportunity costs as defined by socioeconomic and land use vectors, the coefficient is positive and statistically significant: a one standard deviation increase in the index results in a 7 percent increase in conservation within APPs, and a 10 percent increase in conservation outside APPs. Therefore these findings are in line with the hypothesis that prosocial motivations drive conservation both inside and outside APPs.

Proenvironment landholders - those who are concerned about the future supply of water and those concerned about the negative impact of land degrading activities on the environment - are more likely to conserve land outside APPs (Table B.9). Controlling for opportunity costs, if the landholder believes the future supply of water will diminish, conservation of land outside of APPs increases by 80%. A one unit standard deviation increase in the concern of negative land use activities results in a 7 percent increase in conservation outside APPs. This is in line with the hypothesis that those who are concerned for the environment would conserve irrespective of the zoning laws as they value the existence of the environment. The results are robust under different specifications.

These findings are in line with the hypotheses that proenvironment and prosocial motivations drive conservation both within and outside APPs. The results also confirm the hypothesis that stated preferences of conservation are strong predictors of revealed preferences in our survey. This result provides a robustness check for using the factored indices to proxy latent motivations as independent variables in the take up analysis.

However, if the landholder believes that restoration of border areas of rivers and springs through public resources would significantly improve air quality and the environment, conservation of land outside APPs decreases by 12%. Recall that this motivation was perfectly correlated with *attitudes towards government's role in protecting natural resources* from Factor Analysis 3: (see table B.7) those who acknowledge benefits of restoration yet believe it's the government's responsibility to protect and pay to protect natural resources on public property are not incentivised to conserve in absence of financial support.

B.6.2 Take Up of PES Program (Model 3)

Opportunity costs

Opportunity costs are strong predictors of PES enrollment. When participation is regressed only on observable opportunity costs, we see that as household size increases by one member, landholders are 2 percent less likely to participate (Table B.10). Landholders who suffered an income shock and earned less income than usual in the previous year are 10 percent less likely to participate. As the proportion of very steep property increases, the landholder is 15 percent more likely to enroll in the program. Furthermore, landholders who have all required legal documents for their property are 35 percent more likely to enroll in the program. The proxy variables for opportunity cost remain significant and at similar, if not slightly smaller, magnitudes in the fully specified model.

We asked if additional incentives, such as access to technical assistance, would change their participation decision. Free mapping of the property, fencing, seeds/

seedlings and specialised technical assistance were provided as options. An overwhelming 92 percent of landholders replied that access to assistance in any form would not change their participation decision.

Motivations

Those with prosocial motivations are less likely to enroll in the PES program. A one-unit standard deviation increase in prosocial motivation leads to a 5 percent decrease in probability of participating in the program in the fully interacted model. The finding that prosocial motivated landholders are more likely to be conserving land both within and outside APPs before the program is introduced, yet are less likely to then enroll in the program, demonstrates a potential crowding out effect of a government incentives program on prosocial motivated landholders. However, we can only evaluate if crowding out of conservation behaviour occurred once the program has finished.

Those concerned about social norms also are less likely to enroll in the PES program. A one-unit increase in standard deviation in Social norms also has a negative effect on participation; the landholder is 7.8 percent less likely to participate. And if the social norm motivated landholder received a high offer, they are 22 percent less likely to enroll. Recall the social norms indicator is comprised of responses to two questions: if the landholder plans to discuss the project with their neighbor after the survey, and if the landholder would change their decision based on the decision of their neighbor. Our original hypothesis holds that the landholder's participation decision is dependent on their valuation of how conservation behaviour, and how accepting a monetary reward in return for positive conservation outcomes, is judged by their community. The *social connection* moderator is triggered as approaching each landholder individually undermines the social connections within the community.

Proenvironment motivated landholders - on the other hand - are 3 percent more likely to enroll in the program. The incentives program may be activating all psychological moderators under SDT theory: the incentive may be supporting their *self-determination* and *competence* if landholders are acting in accordance with their free will to conserve (as shown in the baseline conservation regressions) and value the compensation as positive feedback on their existing conservation behaviour. It also may support their *environmental connection* if it further supports their desire to feel connected to nature.

Most importantly, access to information is the strongest predictor of take up. Landholders who had heard of PES in general and/or of the specific MdA program, and who fully understand the Forest Code are 13.2 percent more likely to participate in the program.

B.6.3 Qualitative Follow-up Survey

A qualitative survey was administered to those eligible for the program to understand why they accepted or rejected the incentive to enroll in the conservation program. Please note that we do not include these questions in our quantitative analysis as they were administered to the relative subsamples (enrolled versus non enrolled) and thus the quantitative analysis would suffer from selection bias. Furthermore due to the small sample, we would not have enough power to quantitatively estimate the patterns in responses. Instead we highlight the results from the qualitative survey below, which serve as further support of our hypothesised channels through which an incentive supports or undermines motivation and motivations for enrollment.

When asked specifically why the household chose to participate in the program the most common response was “the payment is little but it is an incentive to comply with the law” (Figure B.5). This confirms our quantitative finding that those with access to information are 15 percent more likely to enroll in the program. In line with SDT, the payments may enhance *self-determination* for those well informed through the channel of self-development by learning the legal requirements and context.

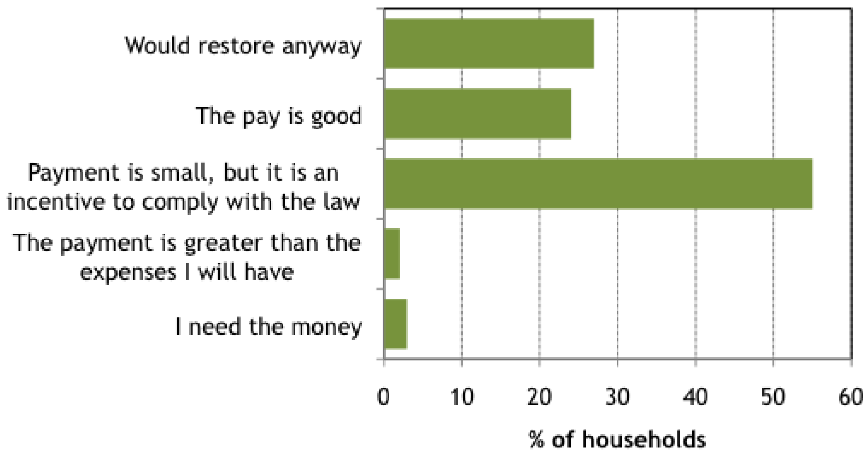


Figure B.5: Motives for enrolling in the PES restoration program

According to our qualitative findings, just over one-quarter of those who accepted the offer were planning to restore regardless of the program. As mentioned earlier, many hypothesise that low rates of reduced deforestation in PES schemes are due to low additionality whereby those already conserving self select into the program. Here we qualitatively observe a possible additionality issue.

Among the 27 percent of households who indicated that they would restore anyway, the most common reason for doing so was to conserve water they consume (Figure B.6). Here we observe validation from our quantitative findings that those who are proenvironment are more likely to conserve land before the introduction of the program, and are more likely to also enroll in the PES program.

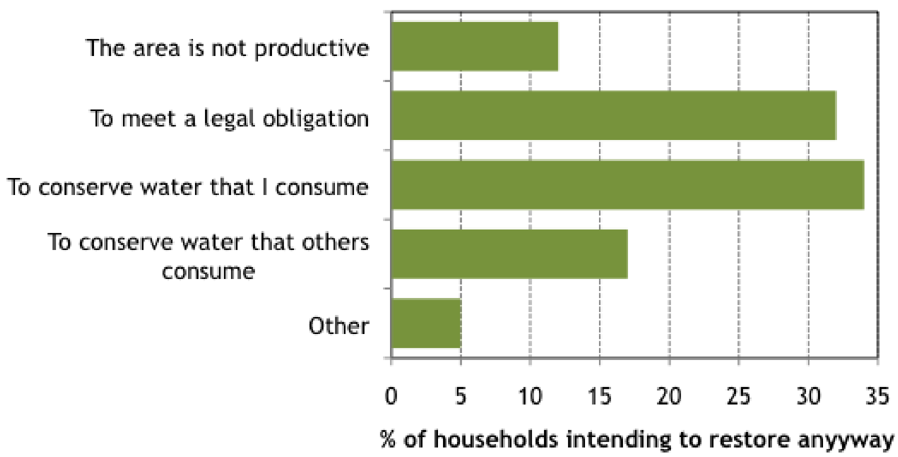


Figure B.6: Motives for intending to restore anyway

Questions were also asked to those who chose not to enroll. The most common response was "the incentive was low" for the conservation program and "recovering a hectare compromises a very productive area" (Figure B.7).

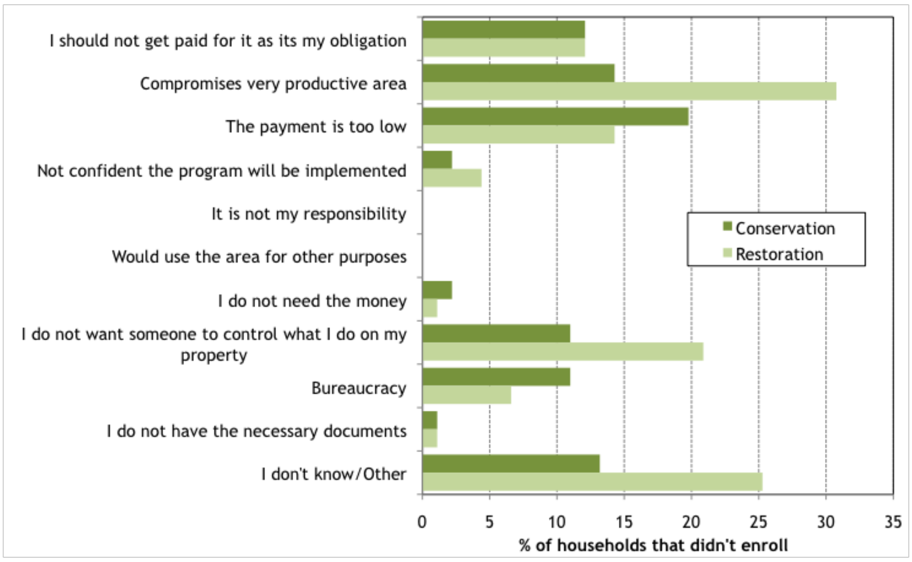


Figure B.7: Motives for not enrolling in the PES program

Thus for both the conservation and restoration program, opportunity costs are a crucial hurdle to increase enrollment. Respondents also mentioned that they did not want someone to control their behaviour on their own property. This response suggests an undermining of self determination by the principal. According to SDT theory, the incentive may feel imposed on the individual and result in a crowding out of their motivation.

B.7 Conclusion

Standard take up analyses of PES programs study the impact of observable opportunity costs on enrollment. We extend this work by further incorporating behavioural determinants (intrinsic motivations) in the enrollment decision. We first disentangle and measure intrinsic motivations, specifically proenvironment, prosocial, progovernment, and social norms. Controlling for proxies for opportunity costs, we then analyse behavioural determinants of take up for the PES program. We discuss the findings in light of SDT, which hypothesises mechanisms through which payments may alter the landholder's self-satisfaction need to feel *competent, self-determined*, and *connected* to others and their environment ("social relatedness" and "environmental relatedness"). The specific design of payments affects these need satisfaction moderators in different ways. The psychological moderators, individually or in combination, drive the crowding in or crowding out effect of a PES incentive on take up.

To first measure latent motivations, we use factor analysis on responses to an exhaustive and multi dimensional questionnaire in the baseline survey for a PES program in the state of São Paulo, Brazil. We then determine if stated conservation preferences predict revealed conservation preferences, as determined by existing level of forest cover on their property before the program is introduced.

The program conditions require conservation only of land already under legal protection by the Brazil Forest Code. We find that prosocial landholders are more likely to be conserving land both within and outside areas of legal protection (APPs) before the program is introduced. These findings are in line with the hypothesis that prosocial motivations drive conservation both within and outside APPs. Proenvironment motivations drive conservation on land outside APPs. The results also confirm the hypothesis that stated preferences of conservation are strong predictors of revealed preferences in our survey. This result provides a robustness check for using the factored indices to proxy latent motivations as independent variables in the take up analysis.

We use the indices to then study determinants of take up to analyse which types of individuals are more likely to enroll in the PES program when controlling for proxies for opportunity costs. Landholders with a low opportunity cost of conservation are already conserving and, in turn, are more likely to enroll in a program which compensates them for their existing behaviour. Thus we would then expect that those with high opportunity costs would not enroll in the program. This finding is supported by the qualitative follow-up survey: the main reason provided to not enroll in the restoration program was because it compromises a productive area of land.

When analyzing behavioural determinants of take up, we observe proenvironment landholders are more likely to enroll in the PES program. The payments may support the landholder's need to feel connected to their environment, and the incentive works to crowd in their motivation. This finding is reinforced by the qualitative follow up survey: the main reason landholders enrolled was to protect water resources. The crux of SDT theory is that self-determination support is necessary to maintain intrinsic motivation. Payments may be seen as a type of positive feedback on a person's performance (*competence*), which can increase intrinsic motivation (Deci, 1971). It is worth noting these landholders are closest to the margin of adopting - as they were already conserving land outside of legal protection but not yet conserving land under legal protection - and a small incentive crowds in their intrinsic motivation.

While we found that prosocial landholders, like proenvironment landholders, are more likely to be conserving land regardless of the legal requirements before the program is introduced, these landholders are *less likely* to enroll in the program. Drawing upon SDT theory, the incentive may undermine their free will and desire to feel connected to their community through their prosocial behaviour. Under this model, such landholders may even reduce their conservation. Further research should explore the dynamic effects of whether the introduction of a monetary incentive program for conservation results in a crowding out of observed conservation behaviour in the long run.

Landholders with social norms motivations are also less likely to enroll in the program. As the program was introduced to each landholder individually, this may have undermined the *social connection* moderator of the landholder's needs satisfaction.

Importantly, one of the largest drivers of enrollment is having information on the Forest Code, the concept of PES, and information on this specific PES program before the survey was administered. This is a key finding for program administrators. Education campaigns that provide this information are likely to increase enrollment.

While individual motivations must be taken into account to assure that PES is cost- effective and results in high additionality, we find the opportunity cost of land is still the most critical hurdle to change land use. If program administrators are concerned that those already engaging in conservation practices self-select into the program, then it is advisable to direct the monetary incentive offer to landholders not conserving because of high opportunity costs to motivate a change in existing behaviour and ensure additional conservation. The survey responses suggest that other incentives such as technical assistance of any kind would not change their participation decision, nor would additional financing. Further research is needed to understand the most effective combination of incentives to promote conservation for those with high opportunity costs of land use.

Our paper sheds light on the importance of using preference questions in a baseline survey to analyse pre existing motivations before the introduction of a payments program for conservation. These questions can be utilised to gain a more comprehensive understanding of the reasons landholders chose whether to enroll in the program. Understanding how pre existing motivations interact with the decision to participate in a PES program can bring important insight to contract design under asymmetric information. If program administrators want to achieve high additional conservation, they could use this information to more efficiently target programs to those who are not yet conserving their land according to program conditions. Further, by repeating studies to have a firmer understanding of the effect of a monetary offer on various intrinsic motivations, program administrators can use the analysis to direct payments to those close to the margin of conserving but need a incentive to comply with the program conditions (like the proenvironment landholders in our sample). They should not offer a monetary incentive to those whose pre existing intrinsic motivations are undermined by the extrinsic incentive (like the prosocial landholders in our sample). To the extent that people do have pre-exiting motivations to conserve, implementation of a PES program might crowd out their conservation behaviour in the long run, whereas if no such motivations existed previously, or the motivations have no effect on participation, then crowding out is unlikely to be an issue. However, further research is needed to understand the long run effect of the introduction and implementation of PES in the community on conservation behaviour for both those who did and did not enroll in the program.

B.8 Graphics and Tables

A Images

Photos: Stefano Pagiola

Figure B.8: Examples of well-conserved springs in Guapiara municipality, with extensive vegetation cover around the spring (the legal requirement is for vegetation in a 50m radius around the spring to be conserved).

Photo: Stefano Pagiola

Figure B.9: Example of poorly conserved spring in Guapiara municipality, with minimal vegetation cover around the spring and steep cultivated slopes in the recharge area above.

Photos: Stefano Pagiola

Figure B.10: Examples of farming landscapes in Guapiara municipality, with cultivated areas and pastures, often on steep slopes, as well as forest remnants and eucalyptus plantations.

B Descriptives and Regressions

Descriptives

Table B.5: Mean characteristics of landholders in the study areas

	Total	Enrolled	Non-enrolled	Ibiúna	Guapiara
Household size	3.92	3.48	3.73	4.05	3.76
	(2.68)	(1.7)	(2.35)	(2.22)	(3.13)
Gender of household head (1=male)	0.85	0.86	0.81	0.88	0.83
	(0.35)	(0.35)	(0.4)	(0.33)	(0.38)
Age of household head	55.37	55.45	54.34	54.05*	56.9
	(13.89)	(13.8)	(13.27)	(14.63)	(12.85)
Education level of household head	2.47	2.6	2.41	2.81***	2.07
	(1.16)	(1.19)	(1.15)	(1.25)	(0.9)
Household income from agriculture	1.35	1.19	1.54	1.28	1.44
	(1.64)	(1.44)	(1.82)	(1.71)	(1.56)
If household uses credit	0.15	0.12	0.17	0.11**	0.19
	(0.35)	(0.33)	(0.38)	(0.31)	(0.39)
Profit (in logs)	12.13	12.13	12.13	12.12	12.14
	(0.14)	(0.1)	(0.13)	(0.18)	(0.08)
Last year's income lower than usual	0.29	0.21**	0.34	0.16***	0.44
	(0.45)	(0.41)	(0.47)	(0.37)	(0.5)
Area of property (in ha)	12.24	13.01	11.04	12.31	12.15
	(13.07)	(14.3)	(13.07)	(13.06)	(13.13)
Number of ag workers	1.97	1.68	1.91	1.52***	2.49
	(2.17)	(1.45)	(1.82)	(1.94)	(2.31)
Possess legal documents	0.88	0.95***	0.83	0.85	0.91
	(0.33)	(0.21)	(0.38)	(0.36)	(0.29)
Land type: Clay	0.26	0.17	0.17	0.32***	0.19
	(0.44)	(0.38)	(0.37)	(0.47)	(0.39)
Land type: Sand	0.26	0.32	0.27	0.34***	0.17
	(0.44)	(0.47)	(0.45)	(0.47)	(0.37)
Land type: Clay-Sand	0.23	0.25	0.2	0.26	0.19
	(0.42)	(0.44)	(0.4)	(0.44)	(0.39)
Land type: Terra Roxa	0.44	0.37**	0.54	0.26***	0.64
	(0.5)	(0.49)	(0.5)	(0.44)	(0.48)
Proportion of property with steep land	0.76	0.77	0.72	0.77	0.74
	(0.28)	(0.28)	(0.29)	(0.26)	(0.3)
Number of ha eroded	0.15	0.11	0.15	0.06***	0.25
	(0.49)	(0.37)	(0.44)	(0.27)	(0.65)
Uses land for agriculture	0.8	0.79	0.84	0.7***	0.93
	(0.4)	(0.41)	(0.37)	(0.46)	(0.26)
Plans to deforest spring	0.04	0.08*	0.02	0.03	0.06
	(0.2)	(0.27)	(0.14)	(0.18)	(0.23)
Conserve land in APPs	0.75	0.77	0.71	0.76	0.74
	(0.33)	(0.33)	(0.37)	(0.33)	(0.33)
Conserve land in Non APPs	0.37	0.38	0.33	0.42***	0.31
	(0.33)	(0.32)	(0.33)	(0.32)	(0.32)
Interested to Participate	1.68	1.59	1.67	1.58**	1.8
	(0.86)	(0.81)	(0.88)	(0.81)	(0.91)

Notes: Standard errors shown in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
T-tests of means: EOI vs. Non-EOI; Guapiara vs. Ibiuna

Table B.6: Factor Analysis II: Community and landholders' responsibility to protect and pay (rotated factors)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Responsible for protecting public resources:							
Community or All	-0.08	0.11	-0.01	0.66	-0.03	-0.02	0.17
Community only	-0.04	-0.06	-0.03	0.66	0.11	0.03	-0.05
End users	0.1	-0.03	-0.02	-0.06	-0.01	0	0.04
Responsible for paying to protect public resources:							
Community or All	-0.07	0.13	0.01	0.13	0.22	0.13	0.57
Community only	0.02	0.01	-0.02	0.17	0.53	-0.04	0.28
End users	0.04	0.1	-0.02	0.02	-0.02	-0.04	-0.1
Responsible for protecting private resources:							
Landowners	-0.02	-0.71	0.02	0.01	-0.17	-0.06	-0.03
Community or All	0.03	0.78	-0.01	0.04	-0.09	0.04	0.04
End users	-0.01	0.1	0	-0.06	0.46	-0.02	0.05
Community only	-0.02	0.36	0	-0.03	-0.03	-0.08	-0.07
Responsible for paying to protect private resources:							
Landowners	0.12	-0.1	0.06	-0.05	-0.01	-0.14	0.1
Community or All	-0.06	0.24	-0.02	-0.03	-0.04	0.55	0.14
End users	-0.02	-0.01	-0.01	0.05	-0.08	-0.04	0.23
Community only	-0.02	-0.03	-0.01	0.08	-0.01	0.48	0
Responsible for protecting the environment for future generations:							
Community, All or Landowners	0.08	0.05	0.03	0	0.06	-0.05	0.01
Landowners only	0.99	0.01	-0.13	-0.02	0	-0.01	-0.01
Community only	0.1	-0.01	0.99	-0.01	0	0	0
Community or Landowners	0.95	0.01	0.32	-0.02	0	-0.01	-0.01
Eigenvalue	**1.94**	**1.37**	**1.12**	**0.94**	**0.61**	**0.59**	**0.54**
Proportion of Variance	**0.31**	**0.22**	**0.18**	**0.15**	**0.1**	**0.09**	**0.09**

Notes: Within each factor, those with high factor loadings in the same direction are included in an index together.

Table B.7: Factor Analysis III: Government's responsibility to protect and pay (rotated factors)

Progovernment: Responses to survey questions	Factor 1 Progovt	Factor 2 -	Factor 3 -
Responsible for protecting water resources on public land: Government only: Government only	0.039	0.364	-0.008
Responsible for paying to protect water resources on public land: Government only	0.376	0.662	0
Responsible for protecting water resources on private land: Government only	0.019	-0.017	0.039
Responsible for paying to protect water resources on private land: Government only	0.882	-0.016	-0.003
Responsible for protecting water resources on private and public land: Government only	0.883	0.335	0.003
Eigenvalue	**1.701**	**0.684**	**0.002**
Proportion of Variance	**0.776**	**0.312**	**0.001**

Notes: Shaded cells show within each factor, those with high factor loadings in the same direction, and thus included in an index together.

Regressions

Table B.8: Stated versus revealed conservation in APPs (Model 1)

	I Means	II Conventional	III Indices
Household size	3.928	-0.022	-0.03
	(0.145)	(0.173)	(0.174)
Education level of household head	2.474	-0.064*	-0.067**
	(0.063)	(0.033)	(0.034)
If household uses credit	0.145	-0.404	-0.483
	(0.019)	(0.324)	(0.377)
Last yr income not typical (earned less)	0.295	0.039	0.092
	(0.025)	(0.439)	(0.503)
Area of property (in ha)	12.296	0.022***	0.021***
	(0.706)	(0.002)	(0.002)
Number of ag workers	1.977	-0.007	0.012
	(0.117)	(0.159)	(0.161)
Possess legal documents	0.879	-0.163	-0.16
	(0.018)	(0.137)	(0.215)
Land type: Sand	0.266	0.331*	0.289*
	(0.024)	(0.197)	(0.161)
Land type: Clay	0.257	0.068	0.085
	(0.024)	(0.195)	(0.216)
Land type: Sand-clay	0.228	0.36	0.345
	(0.023)	(0.233)	(0.256)
Land type: Terra Roxa	0.434	0.051	0.032
	(0.027)	(0.033)	(0.137)
Proportion of total steepness over total property	0.756	0.576	0.535
	(0.015)	(0.422)	(0.483)
Number of properties eroded	0.145	0.274***	0.260***
	(0.026)	(0.054)	(0.058)
Land used for agriculture	0.806	-0.306	-0.266
	(0.021)	(0.646)	(0.791)
Area of non-APP conserved with trees	0.373	0.529	0.635
	(0.018)	(0.6)	(0.647)
Concerned about future supply of water	0.234		-0.248
	(0.023)		(0.154)
Concerned about protecting environment for future generations	0.004		0.074***
	(0.054)		(0.013)
Concerned about behavioral impacts on environment	0.005		0.065
	(0.054)		(0.055)
Pro public-financed restoration	0.002		0.129
	(0.054)		(0.136)
Constant		0.703	0.759
		(0.668)	(0.558)
Observations	346	341	337
Squared correlation between observed and predicted		0.07	0.08

Notes: Standard errors shown in parentheses; *p <0.10, **p <0.05, ***p <0.01

Table B.9: Stated versus revealed conservation in non APPs (Model 2)

	I Means	II Conventional	III Indices
Household size	3.928	0.080***	0.079***
	(0.145)	(0.015)	(0.012)
Education level of household head	2.474	-0.073	-0.083
	(0.063)	(0.065)	(0.075)
If household uses credit	0.145	-0.163	-0.028
	(0.019)	(0.368)	(0.273)
Last yr income not typical (earned less)	0.295	-0.254***	-0.309***
	(0.025)	(0.064)	(0.018)
Area of property (in ha)	12.296	0	0.003
	(0.706)	(0.009)	(0.009)
Number of ag workers	1.977	-0.092**	-0.101***
	(0.117)	(0.046)	(0.033)

Possess legal documents	0.879	-0.025	-0.027
	(0.018)	(0.066)	(0.031)
Land type: Sand	0.266	-0.197**	-0.162***
	(0.024)	(0.083)	(0.05)
Land type: Clay	0.257	-0.057	-0.118***
	(0.024)	(0.073)	(0.025)
Land type: Sand-clay	0.228	-0.032	-0.025
	(0.023)	(0.134)	(0.113)
Land type: Terra Roxa	0.434	-0.22	-0.163
	(0.027)	(0.194)	(0.186)
Proportion of total steepness over total property	0.756	0.213	0.367
	(0.015)	(0.219)	(0.26)
Number of properties eroded	0.145	-0.444*	-0.573***
	(0.026)	(0.269)	(0.213)
Land used for agriculture	0.806	-0.680**	-0.788***
	(0.021)	(0.266)	(0.221)
Area of APPs conserved with trees	0.75	0.409	0.451
	(0.331)	(0.505)	(0.522)
Concerned about future supply of water	0.234		0.729***
	(0.023)		(0.088)
Concerned about protecting env for future generations	0.004		0.096**
	(0.054)		(0.041)
Concerned about behavioral impacts on env	0.005		0.067***
	(0.054)		(0.018)
Pro Public financed restoration	0.002		-0.122***
	(0.054)		(0.033)
Constant		-0.055	-0.303
		(0.325	(0.343)
Observations	346	341	337
Squared correlation between observed and predicted		0.14	0.20

Notes: Standard errors shown in parentheses; *p <0.10, **p <0.05, ***p <0.01

Table B.10: Program take up (Model 3)

Enrolled in MdA	I Means	II Conventional	III Indices	IV Interaction effects
Ibiúna	0.538	0.02	0.078***	0.059***
	(0.027)	(0.031)	(0.015)	(0.01)
Household size	3.928	-0.018***	-0.018***	-0.016***
	(0.145)	(0.003)	(0.003)	(0.005)
Education level of household head	2.474	0.006	-0.001	0.041***
	(0.063)	(0.032)	(0.006)	(0.007)
If household uses credit	0.145	-0.067	-0.093**	-0.094
	(0.019)	(0.047)	(0.047)	(0.061)
Last yr income not typical (earned less)	0.295	-0.099***	-0.048	-0.023
	(0.025)	(0.019)	(0.033)	(0.044)
Area of property (in ha)	12.296	0.001	0.001	0.001
	(0.706)	(0.002)	(0.003)	(0.003)
Number of ag workers	1.977	0.006	-0.002	-0.005
	(0.117)	(0.019)	(0.012)	(0.007)
Possess legal documents	0.879	0.345**	0.317***	0.270***
	(0.018)	(0.146)	(0.056)	(0.025)
Land type: Sand	0.266	-0.162***	-0.096***	-0.071*
	(0.024)	(0.04)	(0.037)	(0.037)
Land type: Clay	0.257	-0.116	-0.084	-0.084
	(0.024)	(0.216)	(0.2)	(0.187)
Land type: Sand-clay	0.228	-0.067***	-0.022	-0.040*
	(0.023)	(0.019)	(0.053)	(0.022)
Land type: Terra Roxa	0.434	-0.25	-0.189	-0.196*
	(0.027)	(0.154)	(0.13)	(0.112)
Proportion of total steepness over total property	0.756	0.152**	0.127***	0.133***
	(0.015)	(0.063)	(0.013)	(0.013)
Number of properties eroded	0.145	-0.047	-0.041	-0.012
	(0.026)	(0.12)	(0.044)	(0.059)
Land used for agriculture	0.806	0.032	-0.001	0.044
	(0.021)	(0.046)	(0.119)	(0.122)
Area of APPs conserved with trees	0.374	0.082	0.044	0.046
	(0.328)	(0.148)	(0.167)	(0.151)
Concerned about future supply of water			-0.033	-0.039
			(0.123)	(0.144)
Concerned about protecting env for future generations			-0.021	-0.048**
			(0.013)	(0.022)
Concerned about behavioral impacts on env			0.044***	0.042*
			(0.009)	(0.025)
Pro public financed restoration			-0.022	0.008
			(0.052)	(0.043)
Social norms			-0.059**	-0.033***
			(0.029)	(0.001)
Access to info			0.129***	0.145***
			(0.003)	(0.004)
High offer	0.483		0.074	0.084
	(0.027)		(0.094)	(0.087)
Concerned about future supply of water * high offer				0.103
				(0.088)
Concerned about protecting env for future generations * high offer				0.187
				(0.116)
Concerned about behavioral impacts on env * high offer				0.021
				(0.214)
Pro public financed restoration * high offer				-0.157
				(0.12)
Social norms * high offer				-0.224***
				(0.002)
Access to info * high offer				-0.086
				(0.112)
Observations	346	204	201	201
Squared correlation between observed and predicted		0.11	0.19	0.23

Notes: Standard errors shown in parentheses; *p <0.10, **p <0.05, ***p <0.01

Appendix C

Appendix to Chapter 3

C.1 Empirical Appendix

A To the baseline findings

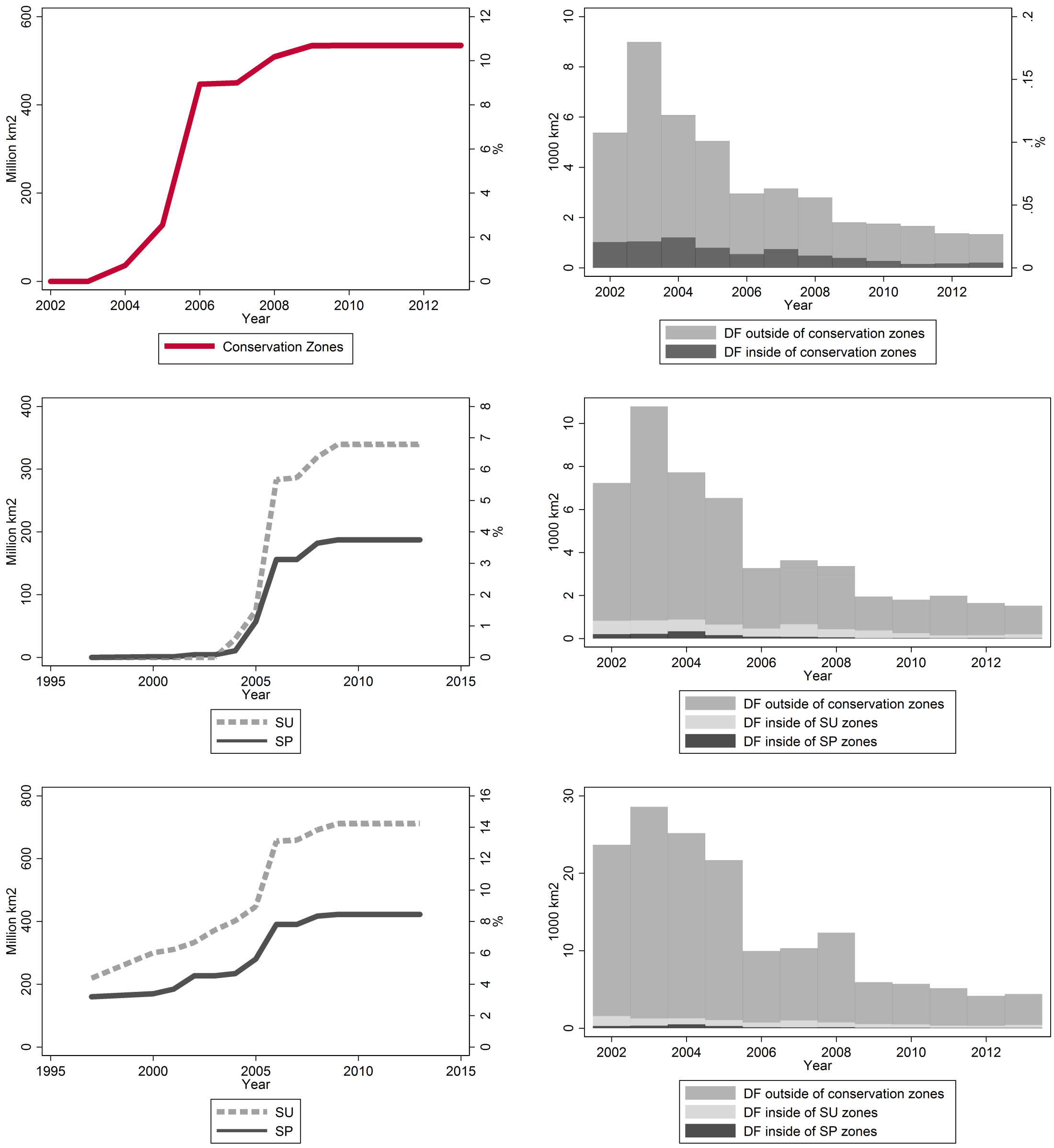


Figure C.1: Areas covered by conservation zones and deforestation rates

Notes: Conservation zones (left panels), deforestation rates (right panel). The four upper panels are for zones established 2004-2010, the two lower panels are for zones established 1959-2012. Figure 3.1 in the main text presents the two upper panels for zones established 2004-2010. Note that the outside area differs, as we we use outside cells based on the shortest distance to a zone. For the 1959-2012 zones, all cells are included. Source: authors own calculations based on data from INPE.

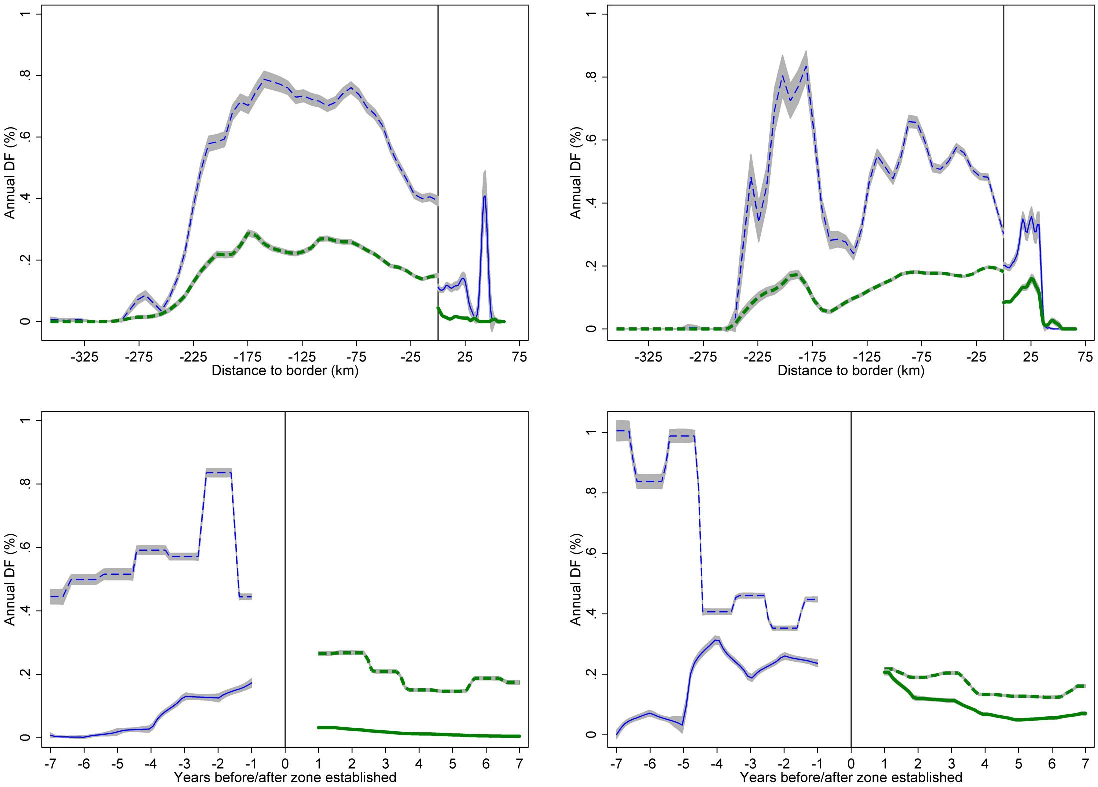


Figure C.2: SP vs. SU zones

Left panel SP-zones, right panel SU-zones, otherwise as figure 3.2.

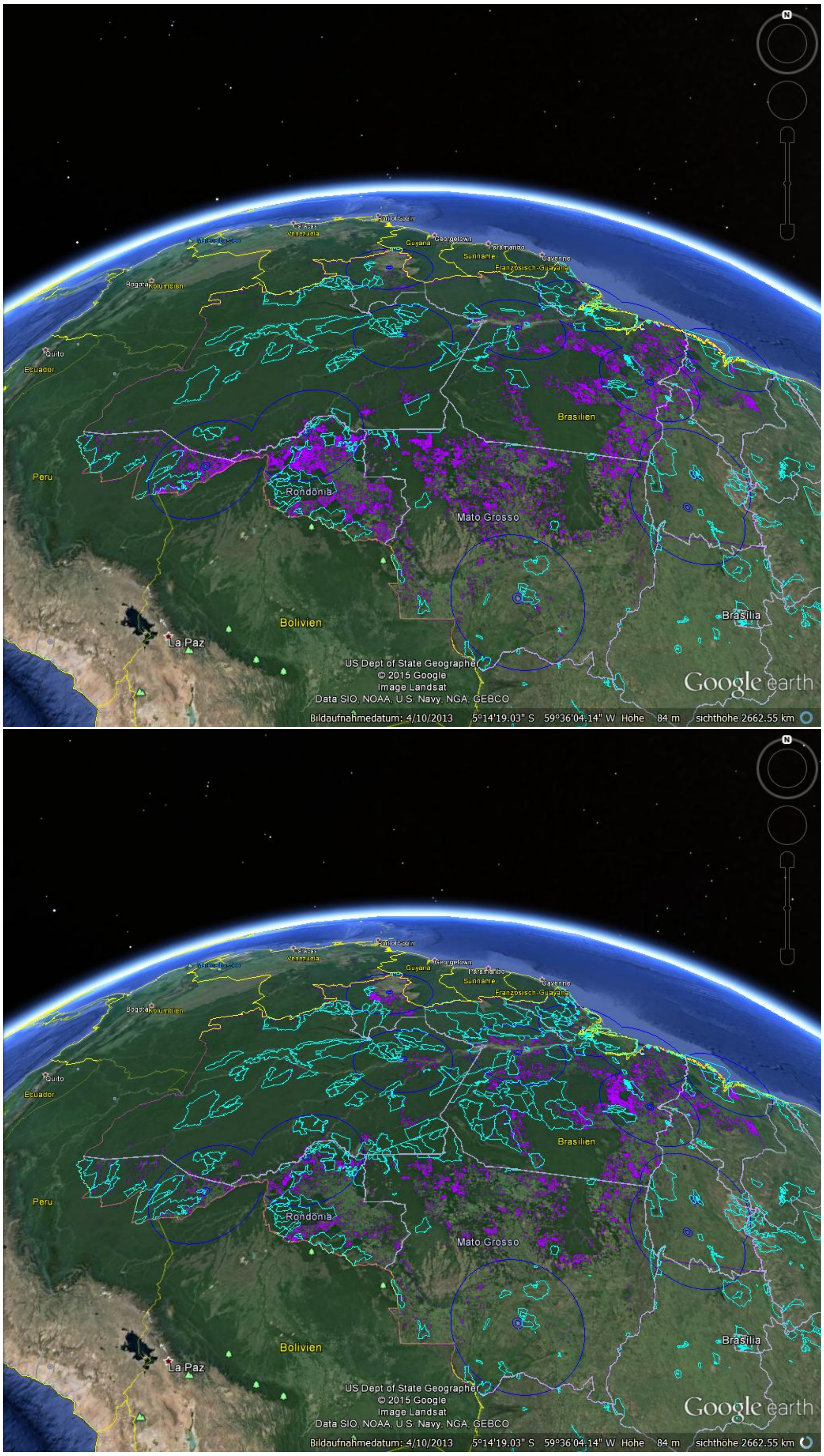


Figure C.3: Zone locations 2005 (upper) and 2008 (lower)

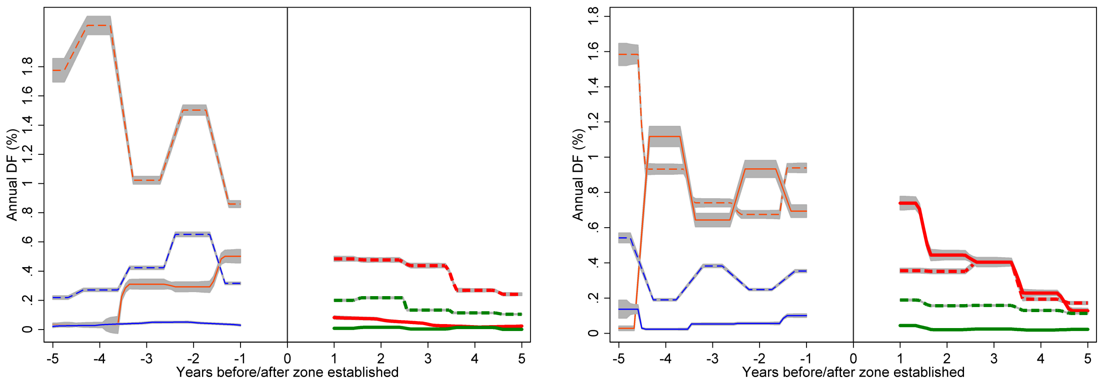


Figure C.4: Priority and non-priority municipalities

Left panel SP-zones, right panel SU-zones, priority municipalities in red; otherwise as figure 3.2.

Table C.2: Soil quality

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0009*	-0.0024***	-0.0005
	(0.0005)	(0.0008)	(0.0006)
D=1 ever in CZ x Post	0.0007	0.0009	0.0006
	(0.0006)	(0.0007)	(0.0007)
D=1 ever in CZ x Post x msoil	-0.0000	-0.0004**	0.0002
	(0.0001)	(0.0002)	(0.0002)
D=1 ever in CZ x msoil	0.0001	0.0005***	-0.0002
	(0.0001)	(0.0002)	(0.0001)
Post x msoil	-0.0002	0.0030	-0.0015
	(0.0007)	(0.0019)	(0.0012)
Observations	1 033 058	282 701	747 769
R-sq	0.037	0.014	0.043
Clusters	877	207	680
Meters from CZ incl.	10 000	10 000	10 000

Notes: As table 3.1, except soil quality. The soil quality is the mean across all cells per municipality and is measured as an deviation from the average of all cells, i.e. the coefficient on the non-interacted variables shown the effect at the general mean of soil quality. The soil quality variable drops out because of municipality-year fixed effects.

Table C.1: Difference-in-Difference estimates of the effect of zoning presenting controls

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0010*	-0.0025***	-0.0004
	(0.0005)	(0.0009)	(0.0006)
D=1 ever in CZ x Post	0.0007	0.0010	0.0005
	(0.0006)	(0.0007)	(0.0007)
Post	-0.0014	0.0002	-0.0011
	(0.0009)	(0.0012)	(0.0012)
ln Dist city	-0.0007***	-0.0002	-0.0008***
	(0.0002)	(0.0002)	(0.0003)
Non-forest	-0.0022***	-0.0022***	-0.0027***
	(0.0006)	(0.0006)	(0.0008)
RF (-1)	0.0003	-0.0020***	0.0014
	(0.0009)	(0.0005)	(0.0012)
Constant	0.0100***	0.0061**	0.0103***
	(0.0023)	(0.0027)	(0.0030)
Observations	1 033 058	282 701	747769
Obs. t<0	389 827	104 929	283497
Obs. t=0	.	.	.
Obs. t>0	643 231	177 772	464 272
Obs. Evertreated t<0	263 007	69 424	189 413
Obs. Evertreated t>0	432 465	11 9734	307 507
R-sq	0.037	0.013	0.043
Clusters	877	207	680
Meters from CZ incl.	10 000	10 000	10 000

Notes: Identical to table 3.1, but presenting controls.

B Robustness checks

Table C.3: Different controls: All zones

	(1) All	(2) All	(3) All	(4) All	(5) All	(6) All	(7) All	(8) All
D=1 ever in CZ	-0.0015***	-0.0015***	-0.0015***	-0.0015***	-0.0010*	-0.0010*	0.0000	0.0000
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(.)	(.)
D=1 ever in CZ x Post	0.0008	0.0008	0.0008	0.0007	0.0008	0.0007	0.0008	-0.0009**
	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0004)
Post	-0.0014	-0.0014	-0.0014	-0.0014	-0.0014	-0.0014	-0.1844	-0.0564
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(8.9801)	(11.9990)
ln Dist city		-0.0006***				-0.0007***		
		(0.0002)				(0.0002)		
Non-forest			-0.0023***			-0.0022***		
			(0.0006)			(0.0006)		
RF (-1)				0.0013*		0.0003		0.2232***
				(0.0008)		(0.0009)		(0.0340)
Dist CZ					-0.0000**	-0.0000**		
					(0.0000)	(0.0000)		
Dist CZ sq					-0.0000*	-0.0000*		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ					0.0000*	0.0000*		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ sq					0.0000*	0.0000*		
					(0.0000)	(0.0000)		
Constant	0.0028***	0.0100***	0.0030***	0.0018**	0.0023***	0.0100***		
	(0.0007)	(0.0024)	(0.0007)	(0.0009)	(0.0007)	(0.0023)		
Observations	1 033 058	1 033 058	1 033 058	1 033 058	1 033 058	1 033 058	1 033 058	1 033 058
R-sq	0.037	0.037	0.037	0.037	0.037	0.037	0.147	0.280

Notes: As table 3.1, different columns vary by the included controls. Column 7 and 8 include cell fixed effect, in addition to the municipality year fixed effects included in all columns.

Table C.4: Different controls: SP zones

	(1) SP	(2) SP	(3) SP	(4) SP	(5) SP	(6) SP	(7) SP	(8) SP
D=1 ever in CZ	-0.0019***	-0.0019***	-0.0019***	-0.0019***	-0.0025***	-0.0025***	0.0000	0.0000
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0009)	(0.0009)	(.)	(.)
D=1 ever in CZ x Post	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011**	-0.0005*
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0004)	(0.0003)
Post	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	-0.0012**	0.0000
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0006)	(0.0007)
ln Dist city		-0.0003				-0.0002		
		(0.0002)				(0.0002)		
Non-forest			-0.0003**			-0.0022***		
			(0.0001)			(0.0006)		
RF (-1)				-0.0007***		-0.0020***		0.1423***
				(0.0002)		(0.0005)		(0.0238)
Dist CZ					0.0000	0.0000		
					(0.0000)	(0.0000)		
Dist CZ sq					0.0000	0.0000		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ					-0.0000	-0.0000		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ sq					-0.0000	-0.0000		
					(0.0000)	(0.0000)		
Constant	0.0012	0.0045*	0.0012	0.0019**	0.0018*	0.0061**		
	(0.0008)	(0.0026)	(0.0008)	(0.0008)	(0.0010)	(0.0027)		
Observations	282 701	282 701	282 701	282 701	282 701	282 701	282 701	282 701
R-sq	0.013	0.013	0.013	0.013	0.013	0.013	0.144	0.227

Notes: As table 3.1, different columns vary by the included controls. Column 7 and 8 include cell fixed effect, in addition to the municipality year fixed effects included in all columns.

Table C.5: Different controls: SU zones

	(1) SU	(2) SU	(3) SU	(4) SU	(5) SU	(6) SU	(7) SU	(8) SU
D=1 ever in CZ	-0.0014**	-0.0013*	-0.0014**	-0.0014**	-0.0005	-0.0004	0.0000	0.0000
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(.)	(.)
D=1 ever in CZ x Post	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0007	-0.0008*
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0005)
Post	-0.0011	-0.0011	-0.0011	-0.0011	-0.0011	-0.0011	-0.0003	0.0001
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0002)	(0.0002)
ln Dist city		-0.0007**				-0.0008***		
		(0.0003)				(0.0003)		
Non-forest			-0.0035***			-0.0027***		
			(0.0010)			(0.0008)		
RF (-1)				0.0023**		0.0014		0.2375***
				(0.0011)		(0.0012)		(0.0395)
Dist CZ					-0.0000***	-0.0000***		
					(0.0000)	(0.0000)		
Dist CZ sq					-0.0000**	-0.0000**		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ					0.0000**	0.0000**		
					(0.0000)	(0.0000)		
D=1 ever in CZ x Dist CZ sq					0.0000**	0.0000**		
					(0.0000)	(0.0000)		
Constant	0.0029***	0.0103***	0.0031***	0.0010	0.0020**	0.0103***		
	(0.0009)	(0.0031)	(0.0009)	(0.0012)	(0.0009)	(0.0030)		
Observations	747 769	747 769	747 769	747 769	747 769	747 769	747 769	747 769
R-sq	0.042	0.042	0.043	0.043	0.042	0.043	0.148	0.290

Notes: As table 3.1, different columns vary by the included controls. Column 7 and 8 include cell fixed effect, in addition to the municipality year fixed effects included in all columns.

Table C.6: Different sample: 5km

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0007	-0.0018*	-0.0004
	(0.0005)	(0.0009)	(0.0006)
D=1 ever in CZ x Post	0.0009	0.0015	0.0006
	(0.0006)	(0.0010)	(0.0008)
Post	-0.0012	-0.0002	-0.0005
	(0.0008)	(0.0014)	(0.0007)
Observations	630 293	164 320	463 374
Obs. t<0	238 120	61 189	175 681
Obs. t=0	.	.	.
Obs. t>0	392 173	103 131	287 693
Obs. Evertreated t<0	164 246	41 488	120 646
Obs. Evertreated t>0	270 064	71 021	196 393
R-sq	0.029	0.017	0.035
Clusters	877	207	680
Meters from CZ incl.	5000	5000	5000

Notes: As table 3.1, but includes only cells up to 5 km from the zone boundaries.

Table C.7: Different sample: 30km

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0012**	-0.0021***	-0.0008
	(0.0005)	(0.0006)	(0.0007)
D=1 ever in CZ x Post	0.0007	0.0008*	0.0005
	(0.0005)	(0.0004)	(0.0007)
Post	-0.0012	-0.0001	-0.0012
	(0.0009)	(0.0007)	(0.0013)
Observations	1690795	548355	1202429
Obs. t<0	633674	201184	453539
Obs. t=0	.	.	.
Obs. t>0	1057121	347171	748890
Obs. Evertreated t<0	384439	114738	260603
Obs. Evertreated t>0	642155	202803	429689
R-sq	0.059	0.012	0.064
Clusters	877	207	680
Meters from CZ incl.	30000	30000	30000

Notes: As table 3.1, but includes only cells up to 30 km from the zone boundaries.

Table C.8: Different sample: All borders

	(1) All	(2) SP	(3) SU
D=1 ever in CZ	-0.0011***	-0.0021***	-0.0007
	(0.0004)	(0.0006)	(0.0005)
D=1 ever in CZ x Post	0.0008*	0.0016**	0.0003
	(0.0005)	(0.0007)	(0.0006)
Post	-0.0012**	0.0011*	-0.0005
	(0.0005)	(0.0006)	(0.0006)
Observations	5 271 706	1 594 140	3 675 396
Obs. t<0	2 042 111	610 056	1 430 196
Obs. t=0	.	.	.
Obs. t>0	3 229 595	984 084	2 245 200
Obs. Evertreated t<0	1 249 983	385 283	843 024
Obs. Evertreated t>0	1 996 427	62 7736	1 337 757
R-sq	0.024	0.017	0.029
Clusters	940	229	711
Meters from CZ incl.	10 000	10 000	10 000

Notes: As table 3.1, but includes all borders.

Table C.9: The priority list, including non-listed municipalities

	(1) All	(2) SP	(3) SU	(4) All	(5) SP	(6) SU
D=1 ever in CZ	-0.0031	-0.0085**	-0.0025	-0.0011*	-0.0026***	-0.0007
	(0.0021)	(0.0040)	(0.0027)	(0.0006)	(0.0010)	(0.0008)
D=1 ever in CZ x Post	0.0038	-0.0003	0.0060*	0.0011*	0.0016**	0.0009
	(0.0026)	(0.0032)	(0.0032)	(0.0006)	(0.0008)	(0.0009)
D=1 ever in CZ x Post x pr_post	-0.0010	0.0028	-0.0026**	-0.0011**	-0.0033***	-0.0005
	(0.0012)	(0.0022)	(0.0011)	(0.0005)	(0.0012)	(0.0006)
D=1 ever in CZ x pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
Post	-0.0058	0.0010	-0.0099*	-0.0035**	-0.0002	-0.0036
	(0.0039)	(0.0034)	(0.0054)	(0.0015)	(0.0013)	(0.0028)
Observations	229 444	69 354	159 157	955 793	270 887	682 044
Controls	64 518	14 258	52 204	316 713	91 691	230 552
Treated	164 926	55 096	106 953	639 080	179 196	451 492
Obs. t<0	88 886	24 340	63 330	340 652	97 559	241 674
Obs. t=0	.	.	.	.	.	.
Obs. t>0	140 558	45 014	95 827	615 141	173 328	440 370
Obs. Evertreated t<0	64 428	18 681	43 732	227 118	63 087	160 503
Obs. Evertreated t>0	100 498	36 415	63 221	411 962	116 109	290 989
R-sq	0.038	0.017	0.044	0.037	0.014	0.043
Clusters	280	84	186	759	176	593
Meters from CZ incl.	10 000	10 000	10 000	10 000	10 000	10 000
Not on pri-list	0	0	0	2	2	2

Notes: Three first columns identical with table 3.3, three last columns include also municipalities never on the list.

Table C.10: Different sample: 5 km, the priority list

	(1) All	(2) SP	(3) SU	(4) All	(5) SP	(6) SU
D=1 ever in CZ	-0.0013	-0.0024	-0.0010	-0.0010***	-0.0016***	-0.0007
	(0.0009)	(0.0015)	(0.0011)	(0.0004)	(0.0006)	(0.0004)
D=1 ever in CZ x Post	0.0022	0.0038**	0.0021	0.0007	0.0019***	0.0001
	(0.0019)	(0.0017)	(0.0032)	(0.0005)	(0.0007)	(0.0006)
D=1 ever in CZ x Post x pr_post	-0.0008	-0.0008	-0.0014	-0.0002	-0.0014**	0.0006
	(0.0016)	(0.0009)	(0.0029)	(0.0004)	(0.0006)	(0.0006)
D=1 ever in CZ x pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
Post	-0.0029**	-0.0025	-0.0036	-0.0023***	0.0002	-0.0010
	(0.0014)	(0.0017)	(0.0023)	(0.0007)	(0.0010)	(0.0007)
Observations	760 034	254 264	507 284	2 872 876	882 386	1976896
Controls	271 002	82 677	192 440	1 038 177	305 791	744 624
Treated	489 032	171 587	314 844	1 834 699	576 595	1 232 272
Obs. t<0	320 745	97 553	222 554	1 063 094	330 886	726 333
Obs. t=0	.	.	.	.	.	.
Obs. t>0	439 289	15 6711	284 730	1 809 782	551 500	1 250 563
Obs. Evertreated t<0	204 424	65 252	137 054	676 789	214 247	452 226
Obs. Evertreated t>0	284 608	106 335	177 790	1 157 910	362 348	780 046
R-sq	0.019	0.017	0.023	0.021	0.018	0.025
Clusters	313	95	208	822	198	624
Meters from CZ incl.	5 000	5 000	5 000	5 000	5 000	5 000
Not on pri-list	0	0	0	2	2	2

Notes: As table 3.3, but includes only cells up to 5 km from the zone boundaries.
$D = 1$ *ever in CZ x pr_post* and *pr_post* drop out.

Table C.11: Different sample: 30 km, the priority list

	(1) All	(2) SP	(3) SU	(4) All	(5) SP	(6) SU
D=1 ever in CZ	-0.0022*	-0.0039***	-0.0011	-0.0018***	-0.0027***	-0.0011*
	(0.0012)	(0.0014)	(0.0016)	(0.0005)	(0.0006)	(0.0007)
D=1 ever in CZ x Post	0.0034	0.0013	0.0048	0.0012**	0.0017**	0.0006
	(0.0028)	(0.0015)	(0.0051)	(0.0006)	(0.0007)	(0.0009)
D=1 ever in CZ x Post x pr_post	-0.0012	0.0003	-0.0030	0.0003	-0.0006*	0.0011
	(0.0023)	(0.0006)	(0.0046)	(0.0005)	(0.0003)	(0.0008)
D=1 ever in CZ x pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
Post	-0.0033	0.0016	-0.0043	-0.0021**	0.0017**	-0.0004
	(0.0020)	(0.0010)	(0.0037)	(0.0009)	(0.0008)	(0.0011)
Observations	2 527 679	1 017 781	1 688 056	9 581 957	3 294 216	6 611 464
Controls	1 141 388	481 437	848 252	4 533 913	1 560 498	3 410 036
Treated	1 386 291	536 344	839 804	5 048 044	1 733 718	3 201 428
Obs. t<0	1 029 713	370 449	714 984	3 512 898	1 212 563	2 410 406
Obs. t=0	.	.	.	.	.	.
Obs. t>0	1 497 966	647 332	973 072	6 069 059	2 081 653	4 201 058
Obs. Evertreated t<0	558 925	192 838	354 788	1 855 820	639 970	1 168 289
Obs. Evertreated t>0	827 366	343 506	485 016	3 192 224	1 093 748	2 033 139
R-sq	0.029	0.017	0.032	0.034	0.021	0.040
Clusters	324	95	229	822	198	624
Meters from CZ incl.	30 000	30 000	30 000	30 000	30 000	30 000
Not on pri-list	0	0	0	2	2	2

Notes: As table 3.3, but includes cells up to 30 km from the zone boundaries.
$D = 1$ *ever in CZ x pr_post* and *pr_post* drop out.

Table C.12: Different sample: All borders, the priority list

	(1) All	(2) SP	(3) SU	(4) All	(5) SP	(6) SU
D=1 ever in CZ	-0.0015	-0.0035**	-0.0006	-0.0012***	-0.0021***	-0.0008
	(0.0010)	(0.0015)	(0.0013)	(0.0004)	(0.0006)	(0.0005)
D=1 ever in CZ x Post	0.0026	0.0029*	0.0032	0.0009*	0.0020***	0.0003
	(0.0023)	(0.0016)	(0.0040)	(0.0005)	(0.0007)	(0.0007)
D=1 ever in CZ x Post x pr_post	-0.0009	-0.0002	-0.0020	0.0000	-0.0013***	0.0009
	(0.0020)	(0.0008)	(0.0037)	(0.0004)	(0.0005)	(0.0006)
D=1 ever in CZ x pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
pr_post	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)	(.)	(.)
Post	-0.0032*	-0.0012	-0.0042	-0.0024***	0.0006	-0.0011
	(0.0017)	(0.0015)	(0.0030)	(0.0008)	(0.0010)	(0.0013)
Observations	1 304 259	448 009	866 825	4 916 480	1 542 436	3366648
Controls	486 075	156 488	344 959	1 870 756	564 892	1 349 618
Treated	818 184	291 521	521 866	3 045 724	977 544	2 017 030
Obs. t<0	545 247	169 482	377 041	1 815 318	577 122	1 233 483
Obs. t=0	.	.	.	.	.	.
Obs. t>0	759 012	278 527	489 784	3 101 162	965 314	2 133 165
Obs. Evertreated t<0	338 587	108 966	225 394	1 122 219	362 831	738 808
Obs. Evertreated t>0	479 597	182 555	296 472	1 923 505	614 713	1 278 222
R-sq	0.022	0.016	0.027	0.024	0.017	0.028
Clusters	324	95	219	822	198	624
Meters from CZ incl.	10 000	10 000	10 000	10 000	10 000	10 000
Not on pri-list	0	0	0	2	2	2

Notes: As table 3.3, but includes all borders.

Appendix D

Appendix to Chapter 4

D.1 OPOWER Home Report example

Figure D.1: Example of OPOWER Home Report

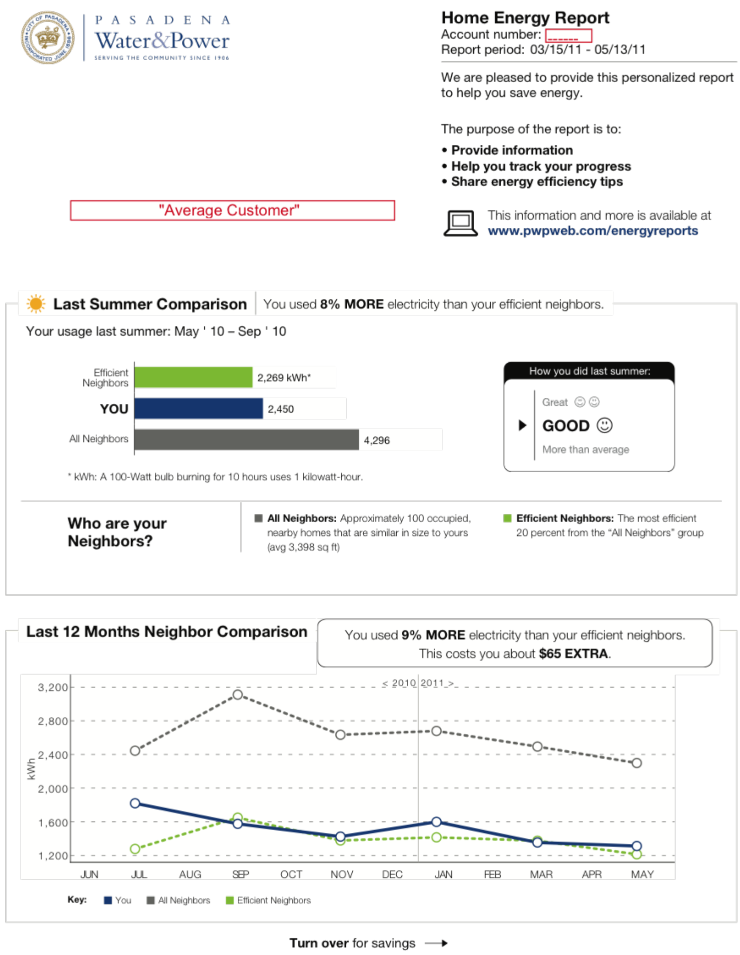
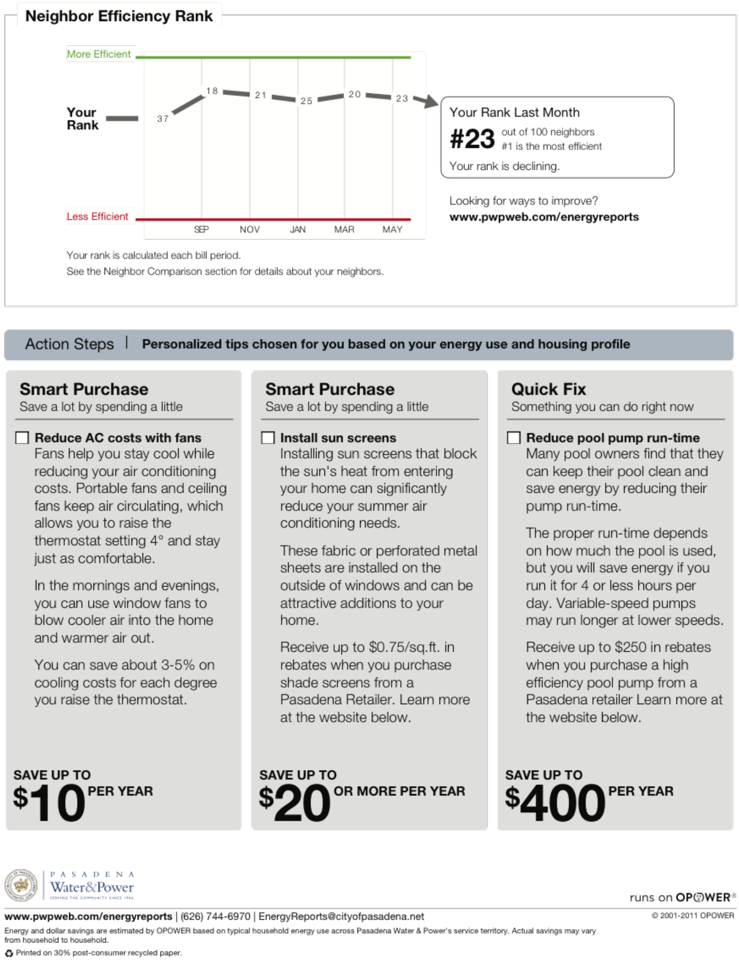


Figure D.2: Example of OPOWER Home Report



D.2 City of Cape Town Utility Bill page 1 example

Figure D.3: City of Cape Town Municipal Bill

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Civic Centre
12 Hertzog Boulevard 8001
PO Box 655 Cape Town 8000
VAT Registration number
4500193497

Tax invoice number	
Customer VAT registration number	
Account number	
Distribution code	
Business partner number	

Tax invoice

Tel: 086 010 3089 - Fax: 086 010 3090
Tel: overseas clients +27 21 401 4701
E-mail: accounts@capetown.gov.za
Correspondence : Director Revenue
PO Box 655 Cape Town 8000
Web address: www.capetown.gov.za

Account summary as at 13/07/2015 **Due date 07/08/2015**

Previous account balance		2759.06
Less payments (07/07/2015)	Thank You	2759.06-
(a)		**0.00**
Latest account - see overleaf		3024.03
Current amount due (b)	**Payable by 07/08/2015**	**3024.03**
	Total (a) + (b)	**3024.03**
Total (a) + (b) above	3024.03	
Total liability	**3024.03**	

To receive this municipal account via e-mail SMS your account number and e-mail address to 31223. Standard SMS rates apply

006528

Current charges totalling R 3024.03 will be debited from your bank account.
Every Capetonian should save water, it is everyone's responsibility to report and fix any leaks.

Please note:

isuinv_20150714_012716.muln

1. Payment options
   (a)Cheques: (i) Made payable to the City of Cape Town. (ii) Limit of R500 000,00. (iii) Post-dated cheques are not acceptable.
   (b)Debit orders: Call 0860 103 089 or visit a Customer Service Centre. (c)Internet payments: Visit Easypay.co.za or payCity.co.za.
   (d)Electronic payments (EFT): Select the City of Cape Town as a bank-listed beneficiary on your bank's website. Use only your nine-digit municipal account number as reference.(e)Direct deposit at ABSA Bank: Please insert your account no. 220039202 on deposit slip.
   (f)Debit/credit card: Only at City vendors reflected below. Bank charges will be levied on your account in respect of single as well as multiple payments in excess of R5 000,00.
2. Interest will be charged on all amounts still outstanding after the due date.
3. You may not withhold payment, even if you have submitted a query to the City concerning this account.
4. Failure to pay could result in your water and/or electricity supply being disconnected/restricted. Immediate reconnection of the supply after payment cannot be guaranteed. A disconnection fee will be charged and your deposit amount might be increased.

Pay points: City of Cape Town cash offices or the vendors below;

ABSA SHOPRITE Checkers WOOLWORTHS SPAR Post Office Pick n Pay EasyPay payCity PEP

Pay online at www.easypay.co.za

Account number	
Amount due if not paid in cash	3024.03
Amount due if paid in cash	3024.00
Rounded down amount carried forward to next invoice	0.03

Figure D.4: City of Cape Town Municipal Bill page 2 example

Account details as at 13/07/2015 **Account number** [redacted]

PROPERTY RATES (Period 12/06/2015 to 13/07/2015) 32 Days

	# Total value		
	From 12/06/2015 : R 4523000.00 @ 0.0062540 ÷ 365 x 19	1472.47	
	# Statutory rebate credit		
	From 12/06/2015 : R 15000.00 @ 0.0062540 ÷ 365 x 19	4.88-	
	# Additional rebate credit		
	From 12/06/2015 : R 185000.00 @ 0.0062540 ÷ 365 x 19	60.23-	
	# Total value		
	From 01/07/2015 : R 4523000.00 @ 0.0068790 ÷ 366 x 13	1105.13	
	# Statutory rebate credit		
	From 01/07/2015 : R 15000.00 @ 0.0068790 ÷ 366 x 13	3.67-	
	# Additional rebate credit		
	From 01/07/2015 : R 185000.00 @ 0.0068790 ÷ 366 x 13	45.20-	
			2463.62

WATER (Period 11/06/2015 to 07/07/2015 - 27 Days) (Actual reading)

	Meter no: / Consumption 22.000 kl / Daily average 0.815 kl		
*	Consumption charge (domestic)		
	From 11/06/2015 : (1) 3.9450 kl free (2) 2.9590 kl @ R 8.7500		
	(3) 6.2470 kl @ R 12.5400 (4) 3.1453 kl @ R 18.5800		
	From 01/07/2015 : (1) 1.3770 kl free (2) 1.0330 kl @ R 9.7100		
	(3) 2.1800 kl @ R 13.9200 (4) 1.1137 kl @ R 20.6200	226.01	
			226.01

REFUSE (Period 12/06/2015 to 13/07/2015) 32 Days

*	Refuse charge (1 X 140L RECYL X 1 Removals)	0.00	
*	Refuse charge (1 X 240lBIN X 1 Removals)	103.95	
			103.95

SEWERAGE (Period 11/06/2015 to 07/07/2015 - 27 Days) (Actual reading)

*	Disposal charge		
	From 11/06/2015 : (1) 2.7620 kl free (2) 2.0710 kl @ R 8.2500		
	(3) 4.3720 kl @ R 14.6400 (4) 2.2024 kl @ R 16.0100		
	From 01/07/2015 : (1) 0.9640 kl free (2) 0.7230 kl @ R 9.1600		
	(3) 1.5260 kl @ R 16.2500 (4) 0.7796 kl @ R 17.7700	161.63	
			161.63

Add 14% VAT on amounts marked with * above **68.82**
0% VAT on amounts marked with # above

Current account: Total due **3,024.03**

Meter details	**Previous reading**	**New reading**	**Units used**
WATER	**6825.000kl(Actual)**	**6847.000kl(Actual)**	**22.000kl**

D.3 Treatments

Figure D.5: Tips

WATER SAVING TIPS

QUICK FIXES
THINGS YOU CAN DO RIGHT NOW

Take shorter showers

A standard showerhead can use as much as 16 litres per minute. If you shorten your shower by only three minutes, you can save up to 48 litres per shower. For a family of four, this amounts to 5 760 litres (5.76 kilolitres) per month!

Don't leave taps running

A running tap can use 20 litres of water per minute. Turn off the tap when brushing your teeth, shaving and washing dishes. If you spend 2 minutes each day brushing your teeth and you leave the tap running, you use 1 200 litres (1.2 kilolitres) per month. This amounts to 4 800 litres (4.8 kilolitres) for a family of four. Reduce your consumption to only a fraction of this by switching off the tap!

Have a smaller bath

If you only fill your bath halfway, you would save between 40 to 75 litres each bath. A saving of 40 litres per bath for a family of four amounts to 4 800 litres (4.8 kilolitres) of water saved every month!

Fix leaks immediately

Leaking taps, showerheads and toilets can waste large amounts of water. A dripping tap can waste between 30 – 60 litres of water a day. That is 900 – 1 800 litres (0.9 – 1.8 kilolitres) per month! Remember that not all leaks are visible.

Practice water-wise gardening

When watering your garden, keep to the times specified in the by-law. Remember to turn off automatic sprinklers when rain is expected.

SMART PURCHASES
SAVE A LOT BY SPENDING A LITTLE

Use a water-saving showerhead

A water-efficient showerhead can use as little as 6 litres of water per minute. Switching from a normal to a water-efficient showerhead can save as much as 10 litres of water per minute. This means a family of four can save 1 200 litres (1.2 kilolitres) per minute each month without any other behavioural change.

Fit taps with water-saving devices

Tap aerators, which screw onto your taps, reduce the flow of water by mixing air into the water flow. While normal tap-flow is between 20-30 litres per minute, these water-saving devices can reduce the flowrate to as little as 6 litres per minute.

Reduce the water used per flush

Older toilets can use as much as 12 litres of water per flush. Converting your existing toilet to a multi-flush (interruptible flush) system can halve your water use per flush. If a family of four flushes the toilet 10 times per day, this is a saving of 1 800 litres (1.8 kilolitres) per month.

Use a pool cover

During hot weather, pool levels can drop by about 1cm per day. Pool covers or blankets can reduce evaporation by up to 90%, saving the water you would use to top up your pool. If your pool level drops by more than 6cm a week, you might have a leak. Look for cracks inside the pool. Remember that automatic top-up systems are not allowed.

Did you know? 1 kilolitre = 1 000 litres

Please call 021 650 5186 on weekdays between 09:00 and 16:00 with queries.

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.

Figure D.6: Tips: Afrikaans language

Figure D.7: Tariff Graph

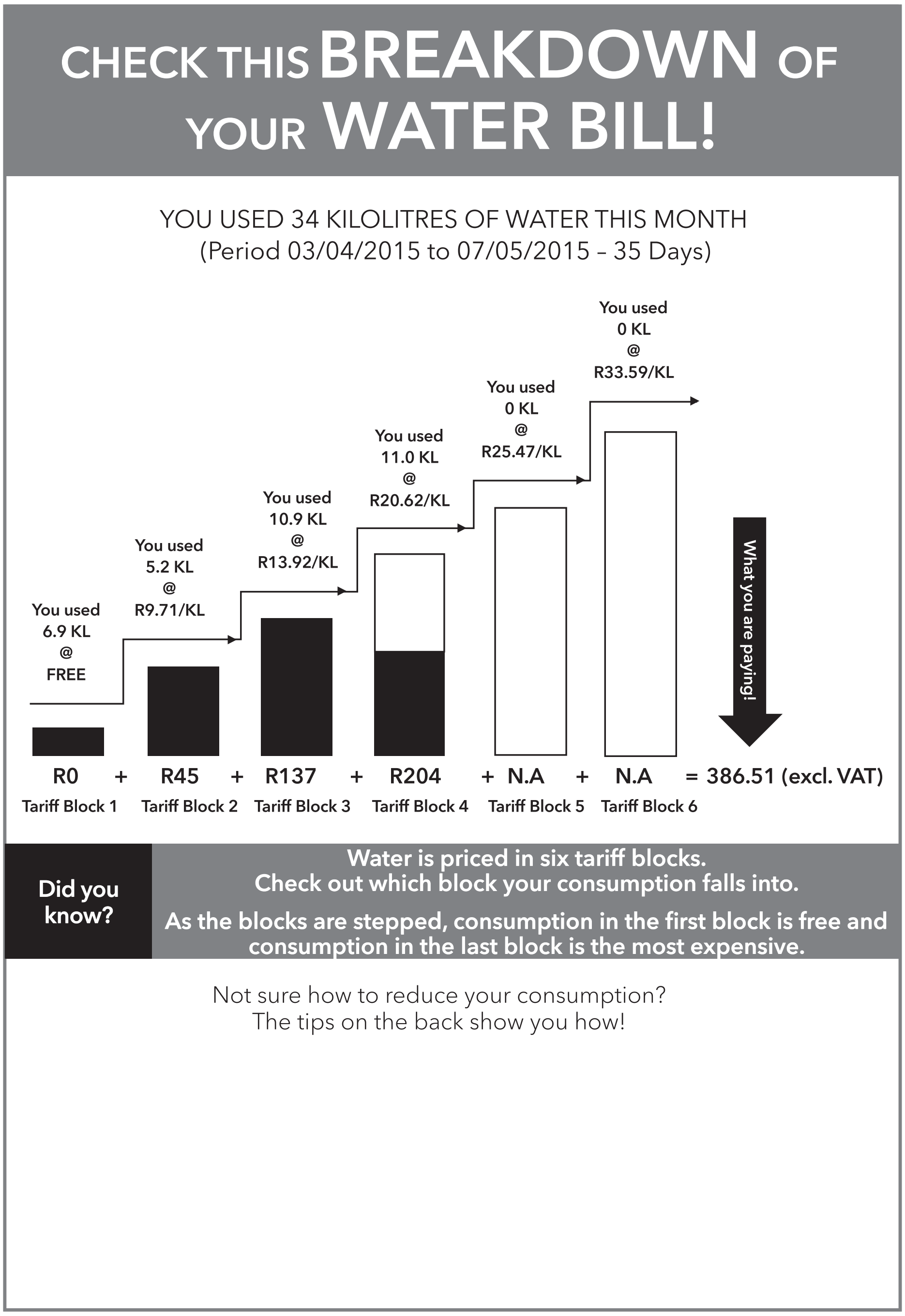


Figure D.8: Tariff Graph: Afrikaans language

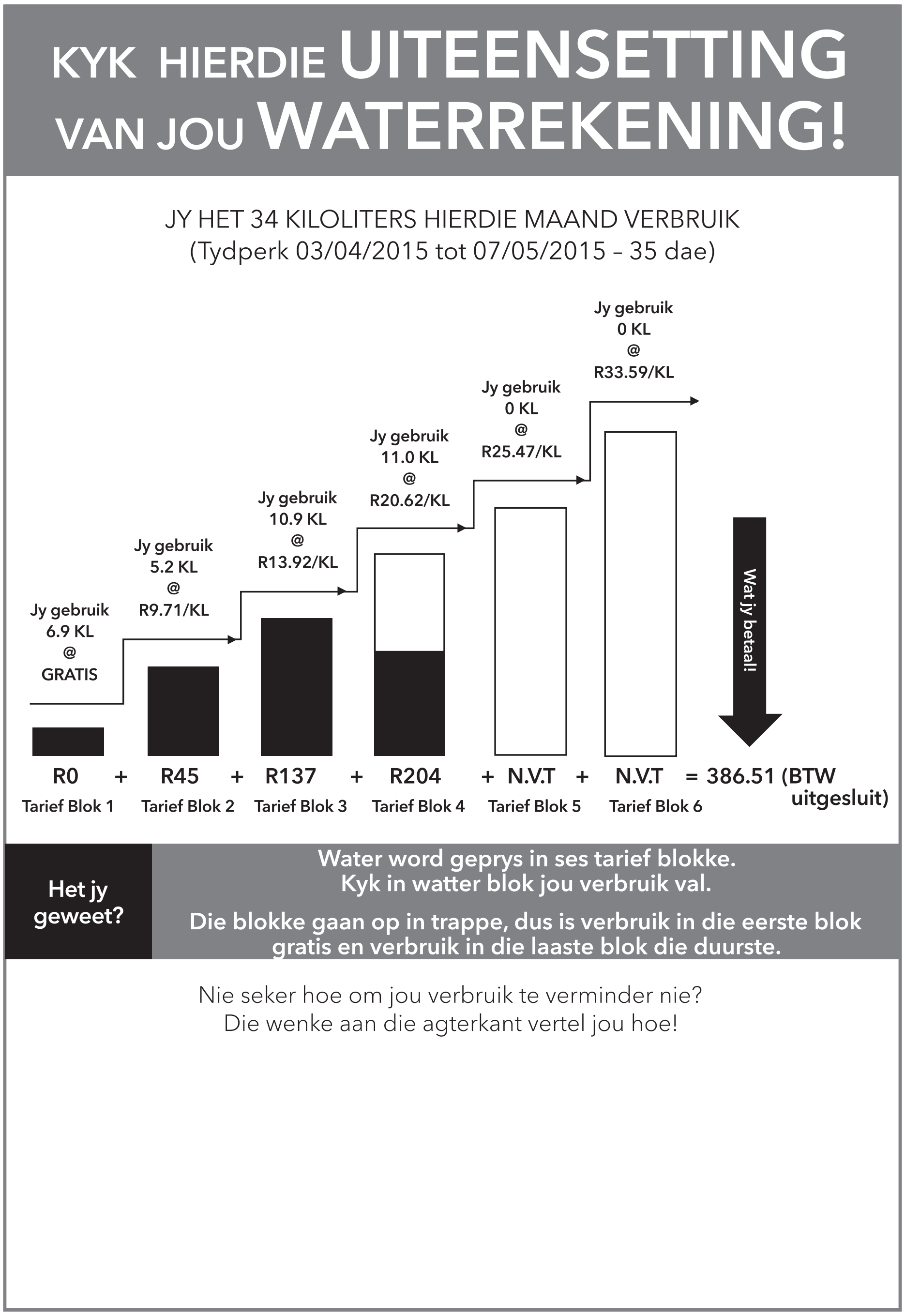


Figure D.9: Financial Gains Message

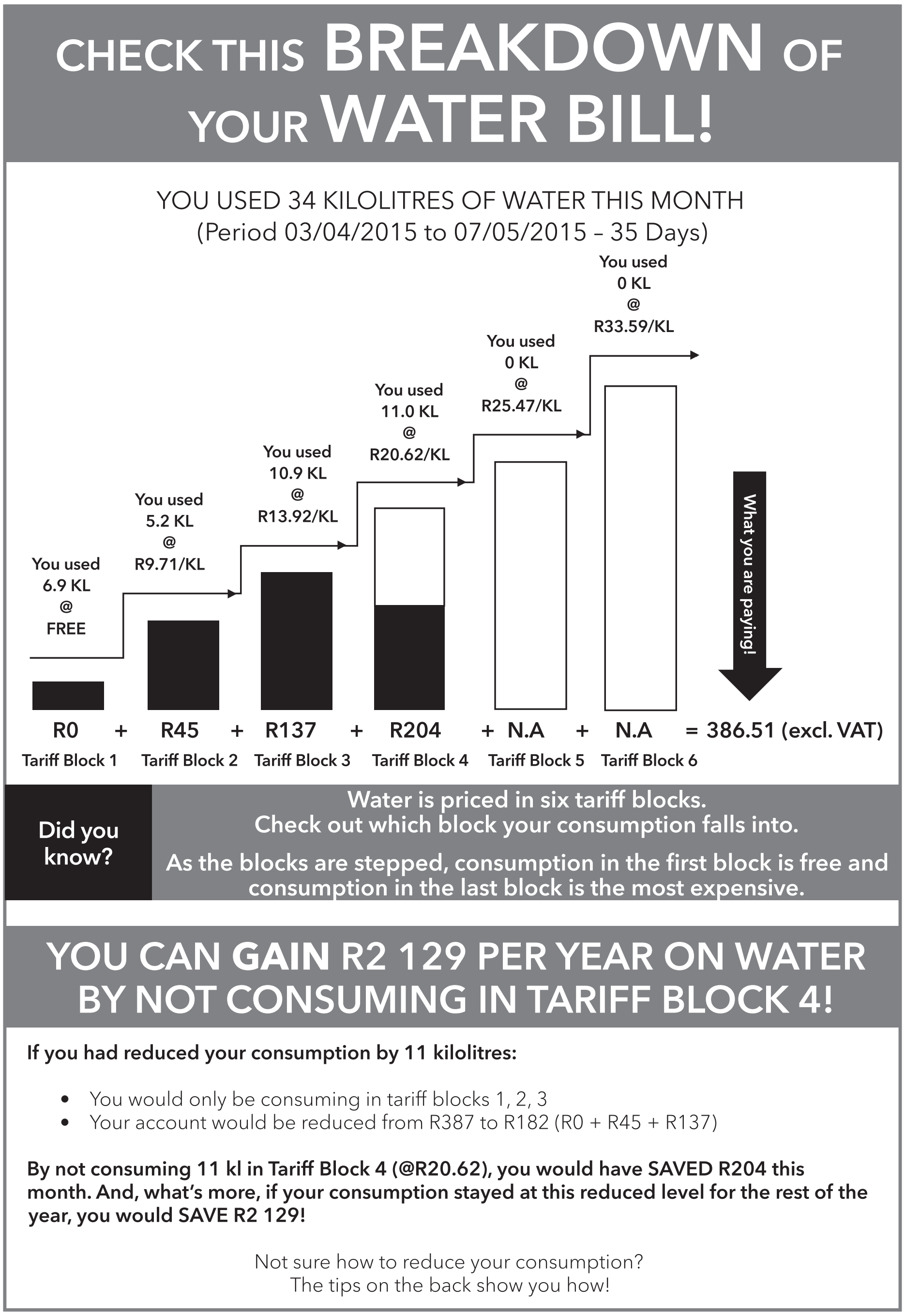


Figure D.10: Financial Gains Message: Afrikaans language

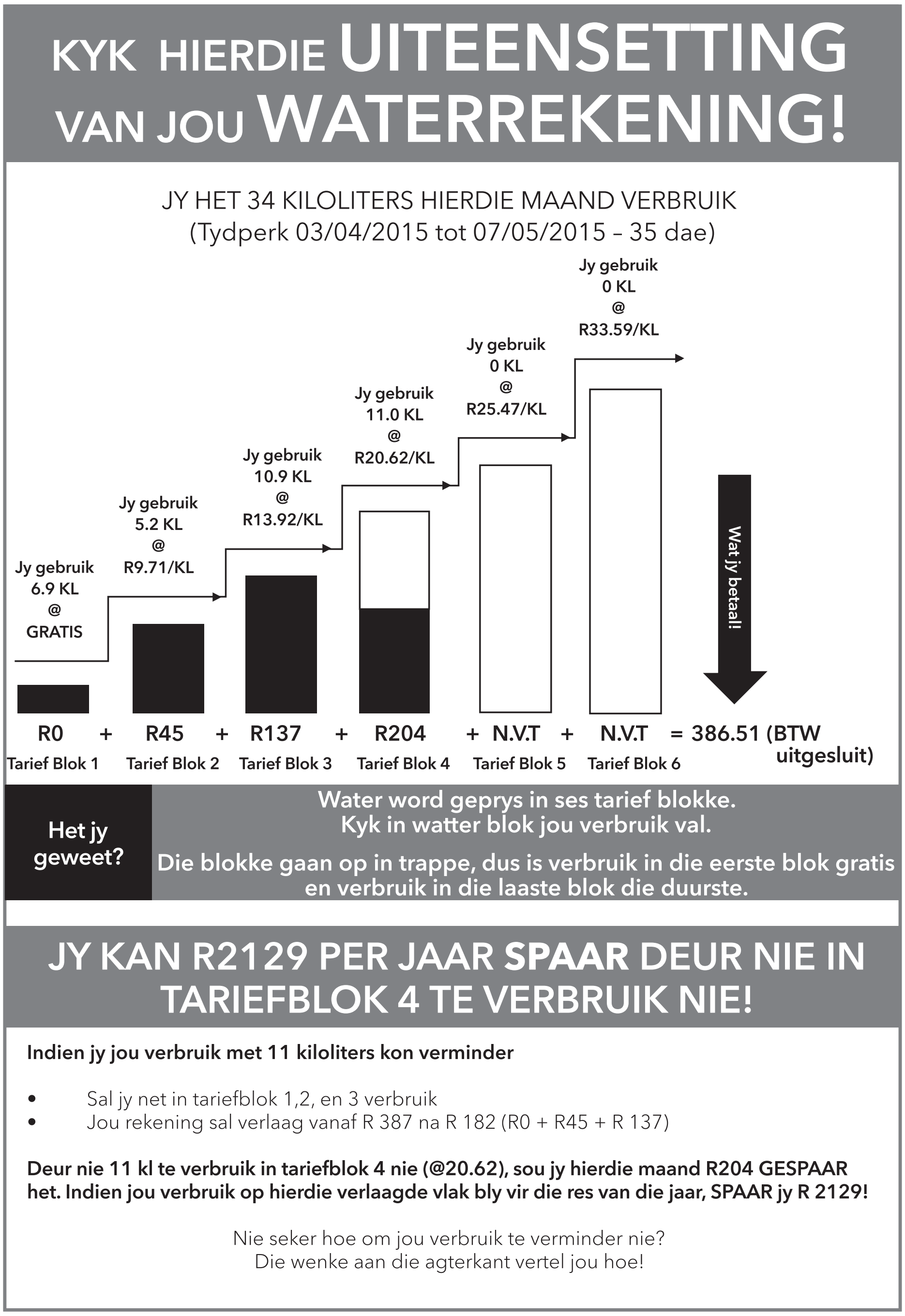


Figure D.11: Social Norm Message

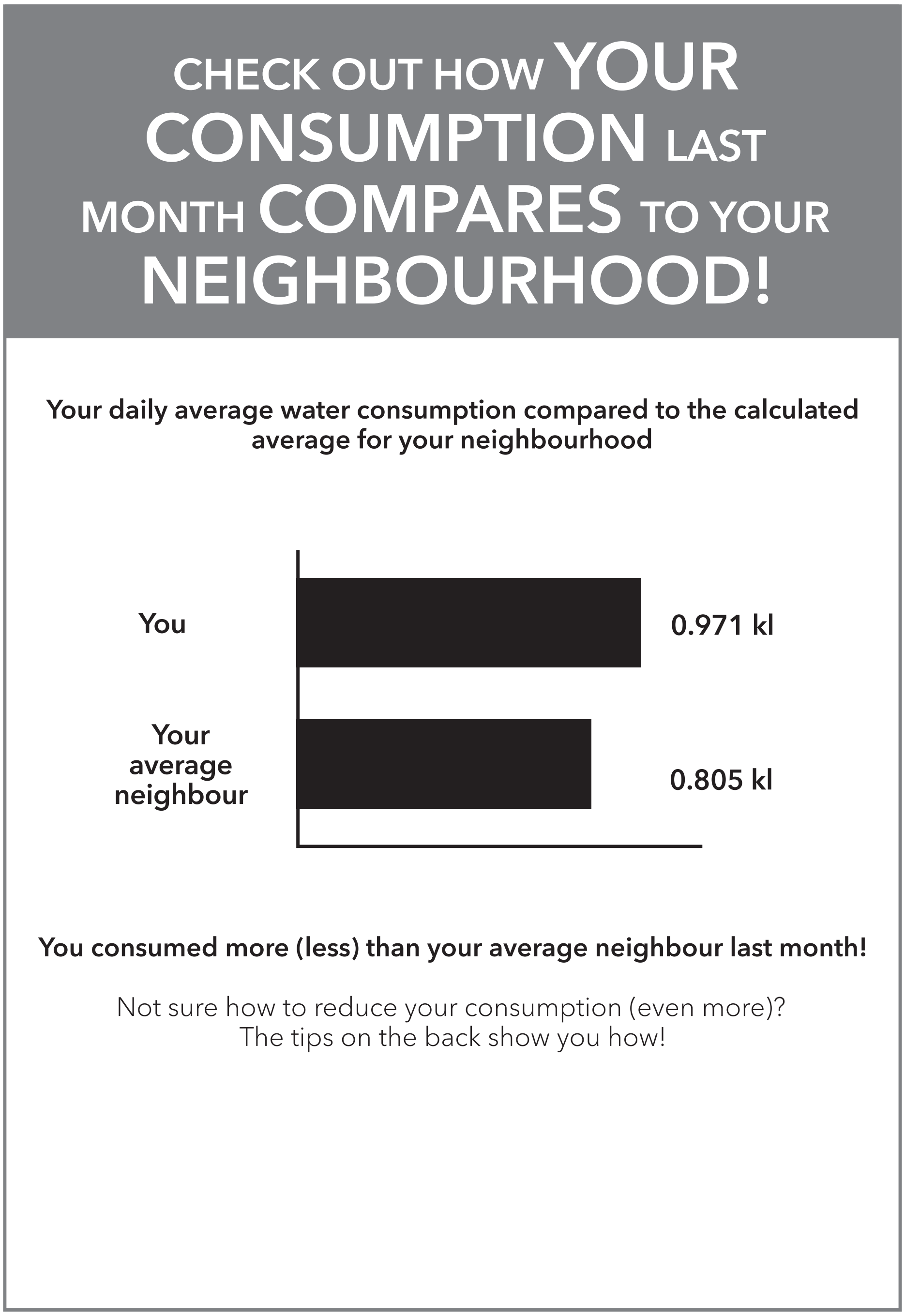


Figure D.12: Social Norm Message: Afrikaans language

Figure D.13: Intrinsic Motivation Message

HELP TO SAVE WATER THIS SUMMER!

- The City is launching a water savings initiative over the summer months when water usage normally increases.
- Please try to reduce consumption by 10% between November and April.
- As you used 34 kl this month, this means you need to keep your monthly consumption around 31 kl.
- You will be notified of how your household did in May.
- **Get saving today!**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure D.14: Intrinsic Motivation Message: Afrikaans language

HELP OM WATER TE BESPAAR HIERDIE SOMER!

- Die Stad loots 'n waterbesparingsprojek gedurende hierdie somer wanneer water verbruik gewoonlik styg.
- Probeer asseblief waterverbruik met 10% verminder vanaf November tot April.
- Aangesien jy hierdie maand 34 kl verbruik het, beteken dit dat jy jou verbruik maandeliks rondom 31 kl sal moet hou.
- Jy sal in kennis gestel word van jou huishouding se prestasie in Meimaand.
- **Begin vandag bespaar!**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

Figure D.15: Public Recognition Message

BE PUBLICLY RECOGNISED
FOR SAVING WATER!

- The City is launching a water savings initiative over the summer months when water usage normally increases.
- Please try to reduce consumption by 10% between November and April.
- As you used 34 kl this month, this means you need to keep your monthly consumption around 31 kl.
- The City will **publicly recognise** the achievement of all water-wise households by **publishing your name and suburb on the City's website.**
- You will be notified of how your household did in May.
- **Get saving today!**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure D.16: Public Recognition Message: Afrikaans language

KRY PUBLIEKE ERKENNING VIR WATERBESPARING

- Die Stad loots 'n waterbesparingsprojek gedurende hierdie somer wanneer water verbruik gewoonlik styg.
- Probeer asseblief waterverbruik met 10% verminder vanaf November tot April.
- Aangesien jy hierdie maand 34 kl verbruik het beteken dit dat jy jou verbruik maandeliks rondom 31 kl sal moet hou.
- Die Stad sal die prestasie van alle huishoudings wat water bespaar aan die **publiek** bekend maak deur jou **naam en woonbuurt op die Stad se webblad te publiseer.**
- Jy sal in kennis gestel word van jou huishouding se prestasie in Meimaand.
- **Begin vandag bespaar!**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

Figure D.17: Public Good Message

A WATER-SCARCE CITY NEEDS EVERYONE TO SAVE WATER!

- Cape Town is a **water-scarce city.**
- As a water scarce region, we **all** need to balance available water resources with increasing demand for water.
- Try to conserve water as much as possible, particularly during the hot and dry summer weather when water usage increases.
- **If everyone saves water now we can prevent future water restrictions!**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure D.18: Public Good Message: Afrikaans language

‘N WATERSKAARS STAD HET NODIG DAT ALMAL WATER SPAAR!

- Kaapstad is ‘n **waterskaars stad.**
- As ‘n waterskaars streek, het ons **ALMAL** nodig om die waterbronne wat beskikbaar is te balanseer teenoor die toenemende vraag vir water.
- Probeer bespaar soveel water as moontlik, spesifiek gedurende die warm droë somer weer wanneer water verbruik vermeerder.
- **As almal nou water spaar kan ons toekomstige waterbeperkinge voorkom!**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke agterop hierdie bladsy wys jou hoe!

D.4 Robustness Checks

Table D.1: Short Run Analysis (Dec 2015): Difference in difference model using fixed effects with trend

	I Monthly consumption (kl)	II Monthly consumption (kl)
Tips	0.118	0.140*
	0.106	0.084
Graph	0.001	0.049
	0.102	0.077
Gain	-0.042	-0.056
	0.114	0.083
Social norm	0.049	-0.025
	0.114	0.088
intrinsic motivation	0.114	0.069
	0.126	0.092
Social recog comp	0.187	0.093
	0.16	0.145
public good	0.108	0.136
	0.143	0.136
Post	-2.629***	-2.717***
	0.24	0.275
Tips x Post	-0.064	-0.089
	0.114	0.109
Graph x Post		
Financial gains x Post	-0.001	0.035
	0.105	0.099
Social norm x Post	-0.005	-0.008
	0.126	0.106
Intrinsic motivation x Post	0.001	-0.066
	0.13	0.111
Social recognition x Post	-0.513***	-0.553***
	0.17	0.174
Public Good x Post	-0.408***	-0.673***
	0.158	0.173
QPV1	-3.638***	-1.768***
	0.526	0.29
QPV2	-4.049***	-1.932***
	0.456	0.277
QPV3	-3.972***	-1.810***
	0.356	0.216
QPV4	-2.758***	-1.144***
	0.234	0.139
Indigent Status	-1.656***	-1.152***
	0.272	0.243
Late receiver	1.391**	0.782
	0.693	0.733
Frequency (-1)		0.029***
		0
Tariff rate (-1)	-0.099	-0.244**
	0.173	0.119
Graph x indigent	-	-
	-	-
Financial gains x indigent	-	-
	-	-
Social norm x indigent	-0.236	-0.015
	0.168	0.131
Intrinsic motivation x indigent	0.081	-0.024
	0.176	0.125
Social recognition x indigent	-0.425	-0.239
	0.307	0.32

Public Good x indigent	-0.539**	-0.406
	0.261	0.262
Tips x indigent x Post	0.019	0.143
	0.178	0.154
Graph x indigent x Post	-	-
	-	-
Financial gains x indigent x Post	-	-
	-	-
Social norm x indigent x Post	0.265	0.034
	0.205	0.169
Intrinsic motivation x indigent x Post	-0.142	0.008
	0.18	0.159
Social recognition x indigent x Post	0.521*	0.434
	0.297	0.33
Public Good x indigent x Post	0.655**	0.709**
	0.268	0.284
Post x indigent	1.750***	1.437***
	0.336	0.33
Constant	16.814***	12.899***
	0.32	0.253
Observations	420352	406203
Treated	357040	345127
Control	63312	61076
Clusters	672	672
Fpvalue	0.081	0.003
R-squared	0.485	0.683

Notes: Standard errors are clustered at the suburb level and are presented below the coefficient. Pre-intervention period: December 2014 - January 2015. Post-intervention period: December 2015 - January 2016. Treated category include all treatments with at most five months of observations.

Table D.2: Longer run analysis (Dec 2015 - April 2016) without CoCT Indigents (Indigent A): Difference in difference model using fixed effects with trend

	I	II	III	IV	V	VI	VII	VIII
	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)
Tips x Post	-0.158*	-0.147*	-0.154*	-0.152**	-0.145*	-0.210***	-0.200***	-0.208**
	0.081	0.081	0.081	0.089	0.082	0.08	0.072	0.081
Graph x Post	-0.178**	-0.179**	-0.175**	-0.190***	-0.178**	-0.188**	-0.199***	-0.198**
	0.082	0.081	0.08	0.072	0.084	0.089	0.072	0.083
Financial gains x Post	-0.215***	-0.214***	-0.218***	-0.205***	-0.185**	-0.272***	-0.251***	-0.244***
	0.077	0.089	0.078	0.069	0.089	0.078	0.069	0.075
Social norm x Post	-0.329***	-0.303***	-0.290***	-0.300***	-0.299***	-0.324***	-0.325***	-0.338***
	0.093	0.093	0.093	0.082	0.094	0.091	0.081	0.092
Intrinsic motivation x Post	-0.327***	-0.291***	-0.257***	-0.284***	-0.273***	-0.295***	-0.315***	-0.312***
	0.086	0.086	0.088	0.089	0.088	0.089	0.08	0.088
Social recognition x Post	-0.465***	-0.347***	-0.325***	-0.364***	-0.380***	-0.395***	-0.425***	-0.452***
	0.096	0.091	0.093	0.089	0.095	0.092	0.089	0.095
Public Good x Post	-0.282***	-0.303***	-0.322***	-0.326***	-0.318***	-0.332***	-0.332***	-0.324***
	0.084	0.082	0.083	0.089	0.084	0.089	0.075	0.086
Trend	-0.298***	-0.293***	-0.110***	-0.310***	-0.304***	-0.126***	-0.326***	-0.320***
	0.028	0.014	0.011	0.014	0.015	0.012	0.014	0.015
Indigent B Status		-0.510***	-0.269	-0.473**	-0.644***	-0.446	-0.883*	-0.758
		0.187	0.18	0.197	0.184	0.54	0.528	0.508
Frequency (-1)			-0.594***			-0.592***		
			0.038			0.038		
Billed amount (-1)				0.005***			0.005***	
				0			0	
Tariff rate (-1)					-0.039***			-0.039***
					0.002			0.002
Tips x Indigent B						-0.634	-0.434	-0.647
						0.578	0.533	0.563
Graph x Indigent B						-0.869	-0.607	-1.114
						0.729	0.656	0.758
Financial gains x Indigent B						-0.948	-0.669	-0.768
						0.597	0.553	0.595
Social norm x Indigent B						-2.447***	-2.103***	-2.437***
						0.871	0.792	0.873
Intrinsic motivation x Indigent B						-0.846	-0.648	-0.982
						0.821	0.736	0.849

Social recognition x Indigent B						-1.538***	-1.190**	-1.569**
						0.565	0.524	0.628
Public Good x Indigent B						-0.934	-0.619	-1.201**
						0.595	0.551	0.61
Tips x Indigent B x Post						0.654*	0.544*	0.716**
						0.369	0.319	0.357
Graph x Indigent B x Post						0.174	0.119	0.251
						0.372	0.326	0.369
Financial gains x Indigent B x Post						0.620*	0.512*	0.653**
						0.334	0.287	0.314
Social norm x Indigent B x Post						0.434	0.324	0.463
						0.456	0.399	0.457
Intrinsic motivation x Indigent B x Post						0.43	0.35	0.444
						0.34	0.299	0.349
Social recognition x Indigent B x Post						0.844***	0.729**	0.850***
						0.327	0.289	0.321
Public Good x Indigent B x Post						0.14	0.075	0.074
						0.34	0.304	0.32
Post x Indigent B						1.685***	1.786***	1.687***
						0.319	0.291	0.308
Constant	26.637***	7.872***	6.437***	5.753***	8.927***	6.559***	5.874***	9.058***
	0.182	0.307	0.337	0.31	0.298	0.338	0.31	0.299
Observations	1779015	1779015	1755075	1755075	1565336	1755075	1755075	1565336
Treated	1561484	1561484	1540696	1540696	1374157	1540696	1540696	1374157
Control	217531	217531	214379	214379	191179	214379	214379	191179
Clusters	674	674	674	674	674	674	674	674
R-squared	0.022	0.221	0.227	0.243	0.222	0.228	0.244	0.224

Notes: Standard errors are clustered at the suburb level and are presented below the coefficient. Pre-intervention period: December 2014 - January 2015. Post-intervention period: December 2015 - January 2016. Treated category include all treatments with at most five months of observations.

Table D.3: Pooled regressions: Monthly consumption

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	V Monthly consumption (kl)	VII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)	XII Monthly consumption (kl)	XIII Monthly consumption (kl)	XIV Monthly consumption (kl)	XV Monthly consumption (kl)
Tips	-0.053	-0.067	-0.07	-0.07	-0.07	-0.07	-0.061	-0.08	-0.108	-0.108	-0.082*	-0.114*
	0.059	0.054	0.055	0.054	0.054	0.054	0.038	0.052	0.067	0.067	0.047	0.063
Graph	0.084	-0.037	-0.041	-0.04	-0.04	-0.042	-0.043	-0.062	-0.077	-0.078	-0.078*	-0.094
	0.062	0.06	0.059	0.059	0.06	0.06	0.043	0.058	0.063	0.063	0.045	0.061
Gain	0.002	-0.114**	-0.113**	-0.113**	-0.113**	-0.115**	-0.070*	-0.118**	-0.169***	-0.171***	-0.120***	-0.173***
	0.068	0.057	0.057	0.057	0.057	0.057	0.04	0.056	0.063	0.063	0.044	0.061
Social norm	-0.083	-0.067	-0.068	-0.068	-0.068	-0.079	-0.063*	-0.097*	-0.209***	-0.218***	-0.155***	-0.220***
	0.056	0.055	0.054	0.054	0.054	0.054	0.038	0.052	0.065	0.065	0.045	0.062
Intrinsic Motivation	-0.103*	-0.165***	-0.164***	-0.164***	-0.164***	-0.175***	-0.140***	-0.173***	-0.216***	-0.225***	-0.179***	-0.228***
	0.063	0.053	0.053	0.053	0.053	0.052	0.04	0.052	0.067	0.067	0.05	0.065
Social recognition	-0.184***	-0.177***	-0.181***	-0.181***	-0.093*	-0.100*	-0.101**	-0.046	-0.232***	-0.239***	-0.226***	-0.177***
	0.054	0.055	0.055	0.055	0.054	0.054	0.041	0.053	0.06	0.06	0.045	0.056
Public Good	-0.188***	-0.182***	-0.184***	-0.184***	-0.109*	-0.108*	-0.107***	-0.073	-0.168**	-0.168**	-0.166***	-0.134*
	0.06	0.058	0.058	0.058	0.057	0.056	0.039	0.057	0.073	0.073	0.05	0.072
Mean pre consumption		0.395***	0.392***	0.392***	0.392***	0.392***	0.261***	0.350***	0.392***	0.392***	0.261***	0.350***
		0.015	0.014	0.014	0.014	0.014	0.013	0.015	0.014	0.014	0.013	0.015
QPV1			-0.792***	-0.797***	-0.799***	-0.803***	-0.587***	-0.715***	-0.799***	-0.803***	-0.587***	-0.715***
			0.237	0.231	0.231	0.23	0.176	0.215	0.23	0.229	0.175	0.214
QPV2			-1.211***	-1.214***	-1.211***	-1.214***	-0.859***	-1.129***	-1.212***	-1.215***	-0.859***	-1.130***
			0.204	0.196	0.197	0.196	0.145	0.172	0.196	0.196	0.145	0.172
QPV3			-1.354***	-1.354***	-1.352***	-1.355***	-0.944***	-1.296***	-1.353***	-1.355***	-0.945***	-1.296***
			0.158	0.158	0.158	0.158	0.114	0.146	0.158	0.158	0.114	0.145
QPV4			-0.982***	-0.982***	-0.982***	-0.984***	-0.644***	-0.943***	-0.983***	-0.985***	-0.645***	-0.943***
			0.104	0.104	0.104	0.104	0.075	0.097	0.104	0.104	0.075	0.097
Indigent Status				0.007	0.007	0.008	-0.007	-0.011	-0.170*	-0.168*	-0.152*	-0.180*
				0.085	0.085	0.085	0.069	0.074	0.102	0.102	0.078	0.094
Late receiver					-0.471***	-0.312***	-0.415***	-0.950***	-0.468***	-0.310***	-0.412***	-0.946***
					0.093	0.113	0.076	0.103	0.091	0.112	0.074	0.102
Frequency (-1)						0.170***				0.170***		
						0.055				0.055		
Billed amount (-1)							0.011***				0.011***	
							0				0	
Tariff rate (-1)								0.178***				0.178***
								0.005				0.005
Tips x indigent									0.113	0.112	0.062	0.098

									0.111	0.111	0.081	0.11
Graph x indigent									-0.097	-0.1	-0.015	-0.121
									0.18	0.18	0.134	0.19
Financial gains x indigent									0.125	0.122	0.156	0.141
									0.157	0.157	0.112	0.153
Social norm x indigent									0.376***	0.370***	0.250***	0.335***
									0.108	0.108	0.075	0.108
Intrinsic motivation x indigent									0.156	0.151	0.119	0.164
									0.102	0.102	0.079	0.103
Social recognition x indigent									0.388***	0.385***	0.344***	0.369***
									0.114	0.114	0.088	0.115
Public Good x indigent									0.172	0.173	0.166**	0.178
									0.113	0.113	0.083	0.115
Constant	13.128***	4.646***	5.538***	5.537***	5.520***	5.377***	6.666***	4.005***	5.580***	5.437***	6.715***	4.061***
	0.072	0.22	0.25	0.253	0.253	0.232	0.184	0.238	0.257	0.235	0.187	0.241
Observations	1 118 128	1027476	1 027 476	1 027 476	1 027 476	1 027 476	1 027 476	913 507	1 027 476	1 027 476	1 027 476	913 507
Treated	955 122	878 191	878 191	878 191	878 191	878 191	878 191	780 981	878 191	878 191	878 191	780 981
Control	163 006	149 285	149 285	149 285	149 285	149 285	149 285	132 526	149 285	149 285	149 285	132 526
Clusters	672	669	669	669	669	669	669	669	669	669	669	669
Fpvalue	0.001	0.005	0.005	0.005	0.1	0.059	0.025	0.07	0.001	0	0	0.002
R-squared	0.426	0.533	0.534	0.534	0.534	0.534	0.591	0.547	0.534	0.534	0.591	0.547

Table D.4: Pooled regressions: Daily averge consumption

	I	II	III	V	VII	IX	X	XI	XII	XIII	XIV	XV
	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)	Daily average (kl)
Tips	0	-0.001	-0.002	-0.002	-0.002	-0.002	-0.001	-0.002	-0.003	-0.003	-0.002	-0.003
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Graph	0.005	0	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.003	-0.003	-0.003	-0.003
	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.003
Gain	-0.002	-0.006**	-0.006**	-0.007***	-0.007***	-0.007***	-0.005**	-0.005**	-0.009***	-0.009***	-0.007***	-0.008***
	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.003
Social norm	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.005	-0.005	-0.003	-0.005*
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Intrinsic Motivation	-0.001	-0.004*	-0.004*	-0.004	-0.004*	-0.004	-0.003	-0.004*	-0.004	-0.004	-0.003	-0.005
	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Social recognition	-0.007***	-0.003	-0.003	-0.003	-0.005**	-0.005**	-0.006***	-0.005**	-0.011***	-0.011***	-0.011***	-0.011***
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Public Good	-0.006**	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003*	-0.003	-0.006*	-0.006*	-0.006**	-0.005
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Mean pre consumption		0.013***	0.013***	0.013***	0.013***	0.013***	0.008***	0.012***	0.013***	0.013***	0.008***	0.012***
		0	0	0	0	0	0	0.001	0	0	0	0.001
QPV1			-0.029***	-0.021***	-0.021***	-0.021***	-0.013**	-0.017**	-0.021***	-0.021***	-0.012**	-0.017**
			0.008	0.008	0.008	0.008	0.006	0.007	0.008	0.008	0.006	0.007
QPV2			-0.040***	-0.035***	-0.035***	-0.035***	-0.021***	-0.030***	-0.035***	-0.035***	-0.021***	-0.030***
			0.007	0.007	0.007	0.007	0.005	0.006	0.007	0.007	0.005	0.006
QPV3			-0.038***	-0.038***	-0.038***	-0.038***	-0.022***	-0.034***	-0.038***	-0.038***	-0.022***	-0.034***
			0.006	0.006	0.006	0.006	0.004	0.005	0.006	0.006	0.004	0.005
QPV4			-0.027***	-0.028***	-0.028***	-0.028***	-0.014***	-0.025***	-0.028***	-0.028***	-0.014***	-0.025***
			0.004	0.004	0.004	0.004	0.003	0.004	0.004	0.004	0.003	0.004
Indigent Status				-0.013***	-0.013***	-0.013***	-0.014***	-0.013***	-0.019***	-0.019***	-0.019***	-0.019***
				0.003	0.003	0.003	0.002	0.003	0.004	0.004	0.003	0.004
Late receiver					0.011***	0.011***	0.013***	0.013***	0.011***	0.011***	0.014***	0.013***
					0.004	0.004	0.003	0.003	0.003	0.004	0.003	0.003
Frequency (-1)						0				0		
						0.002				0.002		
Billed amount (-1)							0.000***				0.000***	
							0				0	
Tariff rate (-1)								0.006***				0.006***
								0				0
Tips x indigent									0.003	0.003	0.001	0.003
									0.005	0.005	0.004	0.005

Graph x indigent									0.004	0.004	0.007	0.002
									0.008	0.008	0.006	0.008
Financial gains x indigent									0.009	0.009	0.010**	0.007
									0.006	0.006	0.004	0.006
Social norm x indigent									0.011**	0.011**	0.006	0.009**
									0.004	0.004	0.003	0.004
Intrinsic motivation x indigent									0.002	0.002	0	0.003
									0.004	0.004	0.004	0.004
Social recognition x indigent									0.017***	0.017***	0.015***	0.016***
									0.004	0.004	0.003	0.004
Public Good x indigent									0.007	0.007	0.006*	0.007
									0.005	0.005	0.004	0.005
Constant	0.433***	0.256***	0.284***	0.286***	0.286***	0.287***	0.331***	0.239***	0.288***	0.289***	0.333***	0.241***
	0.003	0.007	0.008	0.009	0.009	0.008	0.006	0.008	0.009	0.008	0.006	0.008
Observations	1 118 128	1 027 476	1 027 476	1 027 476	1 027 476	1 027 476	1 027 476	913 507	1 027 476	1 027 476	1 027 476	913 507
Treated	955 122	878 191	878 191	878 191	878 191	878 191	878 191	780 981	878 191	878 191	878 191	780 981
Control	163 006	149 285	149 285	149 285	149 285	149 285	149 285	132 526	149 285	149 285	149 285	132 526
Clusters	672	669	669	669	669	669	669	669	669	669	669	669
Fpvalue	0.002	0.209	0.203	0.157	0.057	0.055	0.026	0.197	0.001	0.001	0	0.006
R-squared	0.254	0.313	0.313	0.313	0.313	0.313	0.359	0.323	0.313	0.313	0.359	0.323

Table D.5: Pooled regressions: Relative consumption

	I Relative consumption	II Relative consumption	III Relative consumption	V Relative consumption	VII Relative consumption	IX Relative consumption	X Relative consumption	XI Relative consumption	XII Relative consumption	XIII Relative consumption	XIV Relative consumption	XV Relative consumption
Tips	-0.009**	-0.009**	-0.009**	-0.009**	-0.009**	-0.009**	-0.009***	-0.009***	-0.009**	-0.009**	-0.008**	-0.009**
	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.003	0.003
Graph	-0.016***	-0.016***	-0.012***	-0.010***	-0.010***	-0.010***	-0.011***	-0.010**	-0.009**	-0.009**	-0.009**	-0.009**
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Gain	-0.016***	-0.016***	-0.012***	-0.010***	-0.010***	-0.010***	-0.010***	-0.009**	-0.009**	-0.009**	-0.008**	-0.008**
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Social norm	-0.001	-0.001	-0.002	-0.003	-0.003	-0.002	-0.003	-0.004	-0.008*	-0.008*	-0.008*	-0.010**
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Intrinsic Motivation	-0.010***	-0.010***	-0.011***	-0.012***	-0.012***	-0.012***	-0.012***	-0.011***	-0.010**	-0.009**	-0.009**	-0.010**
	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.004	0.004	0.004	0.004
Social recognition	-0.017***	-0.009**	-0.009**	-0.009**	-0.008**	-0.008*	-0.008**	-0.006	-0.011***	-0.011***	-0.011***	-0.010**
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Public Good	-0.013***	-0.006	-0.006*	-0.007*	-0.006	-0.006	-0.006	-0.005	-0.009**	-0.009**	-0.009**	-0.009**
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
QPV1			0.142***	0.117***	0.117***	0.117***	0.134***	0.105***	0.116***	0.116***	0.134***	0.105***
			0.016	0.014	0.014	0.014	0.015	0.014	0.014	0.014	0.015	0.014
QPV2			0.086***	0.070***	0.070***	0.070***	0.091***	0.058***	0.069***	0.069***	0.090***	0.057***
			0.01	0.01	0.01	0.01	0.011	0.01	0.01	0.01	0.011	0.01
QPV3			0.052***	0.051***	0.051***	0.051***	0.073***	0.043***	0.051***	0.051***	0.072***	0.043***
			0.008	0.007	0.007	0.007	0.008	0.008	0.007	0.007	0.008	0.008
QPV4			0.028***	0.029***	0.029***	0.029***	0.044***	0.024***	0.029***	0.029***	0.044***	0.024***
			0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Indigent Status				0.040***	0.040***	0.040***	0.042***	0.039***	0.038***	0.038***	0.041***	0.036***
				0.008	0.008	0.008	0.008	0.007	0.009	0.009	0.009	0.009
Late receiver					-0.007	-0.009	-0.008	-0.017**	-0.007	-0.008	-0.007	-0.016**
					0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Frequency (-1)						-0.002				-0.002		
						0.003				0.003		
Billed amount (-1)							0.000***				0.000***	
							0				0	
Tariff rate (-1)								-0.004***				-0.004***
								0				0
Tips x indigent									0	0	-0.001	-0.001
									0.008	0.008	0.008	0.008
Graph x indigent									-0.029*	-0.029*	-0.029*	-0.025
									0.016	0.016	0.016	0.016

Financial gains x indigent									-0.024*	-0.024*	-0.026**	-0.022*
									0.013	0.013	0.013	0.013
Social norm x indigent									0.015*	0.015*	0.013	0.016*
									0.009	0.009	0.009	0.009
Intrinsic motivation x indigent									-0.006	-0.006	-0.006	-0.003
									0.008	0.008	0.008	0.008
Social recognition x indigent									0.01	0.01	0.009	0.011
									0.009	0.009	0.009	0.009
Public Good x indigent									0.008	0.008	0.009	0.01
									0.008	0.008	0.008	0.009
Constant	0.01	-0.01	-0.071***	-0.076***	-0.076***	-0.074***	-0.102***	-0.028**	-0.075***	-0.074***	-0.102***	-0.027**
	0.007	0.01	0.012	0.012	0.012	0.012	0.013	0.012	0.012	0.013	0.014	0.012
Observations	857676	857 676	857 676	857 676	857 676	857 676	857 676	779 426	857 676	857 676	857 676	779 426
Treated	733 762	733 762	733 762	733 762	733 762	733 762	733 762	666 825	733 762	733 762	733 762	666825
Control	123 914	123 914	123 914	123 914	123 914	123 914	123 914	112 601	123 914	123 914	123 914	112 601
Clusters	669	669	669	669	669	669	669	669	669	669	669	669
Fpvalue	0	0.001	0.016	0.034	0.029	0.031	0.022	0.068	0.227	0.236	0.258	0.252
R-squared	0.027	0.031	0.033	0.033	0.033	0.033	0.045	0.041	0.033	0.033	0.045	0.041

Table D.6: Difference in Difference: no FE, no trend

	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)	Monthly consumption (kl)
Tips	0.047	0.04	0.037	0.038	0.038	0.034	0.032	0.028	0.098	0.105	0.082	0.096
	0.081	0.08	0.08	0.08	0.08	0.081	0.05	0.076	0.102	0.104	0.064	0.098
Graph	0.599***	0.520***	0.516***	0.500***	0.500***	0.495***	0.449***	0.461***	0.175*	0.176*	0.162***	0.134
	0.103	0.101	0.1	0.101	0.101	0.102	0.064	0.096	0.095	0.097	0.059	0.091
Gain	0.535***	0.474***	0.470***	0.455***	0.455***	0.448***	0.399***	0.429***	0.156	0.158	0.128**	0.128
	0.1	0.097	0.097	0.096	0.096	0.098	0.063	0.09	0.098	0.099	0.061	0.09
Social norm	-0.085	-0.068	-0.071	-0.067	-0.067	-0.059	-0.043	-0.106	0.101	0.107	0.068	0.074
	0.082	0.081	0.08	0.081	0.081	0.083	0.051	0.078	0.107	0.109	0.068	0.1
intrinsic motivation	0.035	0.056	0.054	0.059	0.059	0.037	0.009	0.015	0.174	0.165	0.106	0.123
	0.085	0.084	0.084	0.084	0.084	0.085	0.051	0.078	0.111	0.113	0.068	0.102
Social recog comp	0.068	0.058	0.001	0.004	0.03	0.025	0.064	0.038	0.156	0.159	0.144**	0.175
	0.086	0.085	0.086	0.086	0.088	0.091	0.055	0.084	0.114	0.117	0.072	0.109
public good	0	0.004	-0.044	-0.039	-0.018	-0.017	0.064	-0.015	0.132	0.133	0.157**	0.134
	0.077	0.076	0.077	0.076	0.077	0.078	0.048	0.074	0.099	0.1	0.062	0.094
Post	-1.626***	-1.628***	-1.680***	-1.676***	-1.677***	-1.787***	-2.271***	-1.495***	-2.336***	-2.463***	-2.873***	-2.183***
	0.13	0.13	0.129	0.129	0.129	0.122	0.114	0.141	0.135	0.119	0.132	0.141
tips x Post	-0.109	-0.109	-0.103	-0.104	-0.103	-0.1	-0.108**	-0.101	-0.185**	-0.192**	-0.162***	-0.190**
	0.074	0.074	0.074	0.074	0.074	0.075	0.047	0.077	0.085	0.087	0.057	0.092
graph x Post	-0.780***	-0.783***	-0.776***	-0.779***	-0.779***	-0.766***	-0.764***	-0.769***	-0.252***	-0.252***	-0.294***	-0.222**
	0.112	0.113	0.112	0.112	0.112	0.112	0.082	0.119	0.085	0.086	0.06	0.09
gain x Post	-0.795***	-0.801***	-0.795***	-0.798***	-0.798***	-0.783***	-0.685***	-0.793***	-0.315***	-0.317***	-0.244***	-0.290***
	0.102	0.104	0.102	0.102	0.102	0.104	0.073	0.108	0.082	0.084	0.054	0.087
socialnorm x Post	0.061	0.061	0.081	0.082	0.082	0.07	0.032	0.098	-0.242***	-0.251***	-0.181***	-0.229**
	0.079	0.079	0.079	0.079	0.079	0.08	0.05	0.083	0.093	0.094	0.058	0.096
intrinsic x Post	-0.078	-0.077	-0.058	-0.057	-0.057	-0.038	-0.054	-0.021	-0.312***	-0.306***	-0.258***	-0.266***
	0.071	0.072	0.072	0.072	0.072	0.073	0.048	0.076	0.091	0.093	0.063	0.095
sro x Post	-0.226***	-0.220***	-0.221***	-0.220***	-0.218***	-0.214**	-0.303***	-0.178**	-0.487***	-0.491***	-0.522***	-0.462***
	0.083	0.082	0.082	0.082	0.082	0.085	0.059	0.086	0.094	0.097	0.072	0.099
pg x Post	-0.017	-0.017	-0.072	-0.071	-0.068	-0.068	-0.206***	-0.012	-0.259***	-0.257***	-0.357***	-0.213**
	0.074	0.074	0.075	0.075	0.075	0.074	0.048	0.079	0.087	0.088	0.058	0.09
Indigent Status				-0.406**	-0.406***	-0.396**	-0.087	-0.370***	-1.527***	-1.511***	-1.150***	-1.536***
				0.157	0.157	0.156	0.114	0.142	0.234	0.237	0.179	0.233
Late receiver					-0.152	-0.142	-0.226***	-0.690***	-0.161	-0.145	-0.230***	-0.688***
					0.109	0.114	0.077	0.093	0.107	0.112	0.076	0.093
Frequency (-1)						0.034				0.047		
						0.042				0.042		

Billed amount (-1)							0.019***				0.019***	
							0				0	
Tariff rate (-1)								0.326***				0.326***
								0.006				0.006
Tips x indigent									-0.189	-0.227	-0.160*	-0.216
									0.158	0.158	0.092	0.147
Graph x indigent									0.741**	0.756**	0.496**	0.661**
									0.348	0.353	0.205	0.316
Financial gains x indigent									0.443*	0.401*	0.316**	0.372*
									0.237	0.243	0.158	0.22
Social norm x indigent									-0.273*	-0.276*	-0.135	-0.300**
									0.155	0.159	0.099	0.151
Intrinsic motivation x indigent									-0.127	-0.168	-0.091	-0.105
									0.165	0.164	0.099	0.156
Social recognition x indigent									-0.265	-0.293*	-0.14	-0.301*
									0.161	0.169	0.108	0.155
Public Good x indigent									-0.292**	-0.298**	-0.147	-0.288**
									0.144	0.148	0.09	0.141
Post x indigent									1.969***	1.931***	1.817***	2.056***
									0.215	0.219	0.179	0.249
Tips x indigent x Post									0.259	0.296*	0.179*	0.281*
									0.165	0.166	0.097	0.166
Graph x indigent x Post									-0.555	-0.574	-0.365*	-0.555
									0.351	0.358	0.215	0.342
Financial gains x indigent x Post									-0.088	-0.047	-0.063	-0.076
									0.221	0.23	0.153	0.23
Social norm x indigent x Post									0.525***	0.527***	0.270***	0.524***
									0.149	0.154	0.094	0.162
Intrinsic motivation x indigent x Post									0.340**	0.380***	0.237**	0.303*
									0.146	0.145	0.098	0.158
Social recognition x indigent x Post									0.573***	0.599***	0.443***	0.609***
									0.158	0.164	0.112	0.165
Public Good x indigent x Post									0.311**	0.316**	0.214**	0.326**
									0.153	0.155	0.093	0.158
Constant	14.971***	18.111***	21.736***	21.787***	21.789***	21.844***	19.434***	17.628***	22.132***	22.185***	19.755***	17.983***
	0.081	0.31	0.418	0.42	0.42	0.412	0.361	0.361	0.424	0.413	0.367	0.364
Observations	2 074 219	2 074 219	2 074 219	2 074 219	2 074 219	2 042 709	2 042 709	1 821 003	2 074 219	2 042 709	2 042 709	1 821 003
Treated	1 769 214	1 769 214	1 769 214	1 769 214	1 769 214	1 742 722	1 742 722	1 553 673	1 769 214	1 742 722	1 742 722	1 553 673
Treat1	313 199	313 199	313 199	313 199	313 199	308 128	308 128	274 927	313 199	308 128	308 128	274 927
Treat2	225 771	225 771	225 771	225 771	225 771	222 735	222 735	198 680	225 771	222 735	222 735	198 680
Treat3	223 460	223 460	223 460	223 460	223 460	220 433	220 433	196 652	223 460	220 433	220 433	196 652
Treat4	236 743	236 743	236 743	236 743	236 743	233 000	233 000	207 937	236 743	233 000	233 000	207 937
Control	305 005	305 005	305 005	305 005	305 005	299 987	299 987	267 330	305 005	299 987	299 987	267 330

Clusters	672	672	672	672	672	672	672	672	672	672	672	672
Fpvalue	0	0	0	0	0	0	0	0	0	0	0	0.001
R-squared	0.416	0.421	0.44	0.44	0.44	0.441	0.588	0.476	0.441	0.442	0.588	0.477

Table D.7: Fixed Effects no trend

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	V Monthly consumption (kl)	VII Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)	XII Monthly consumption (kl)	XIII Monthly consumption (kl)	XIV Monthly consumption (kl)
Post	-1.662***	-1.662***	-1.722***	-1.738***	-1.738***	-1.647***	-1.894***	-1.797***	-2.421***	-2.352***	-2.546***	-2.514***
	0.134	0.134	0.133	0.132	0.132	0.134	0.121	0.146	0.134	0.127	0.129	0.144
Tips x Post	-0.137*	-0.137*	-0.129*	-0.127*	-0.127*	-0.128*	-0.127*	-0.101	-0.202**	-0.210***	-0.201***	-0.191**
	0.073	0.073	0.072	0.072	0.072	0.073	0.065	0.072	0.08	0.08	0.072	0.083
Graph x Post	-0.815***	-0.815***	-0.809***	-0.795***	-0.795***	-0.779***	-0.774***	-0.808***	-0.239***	-0.234***	-0.242***	-0.231***
	0.113	0.113	0.112	0.112	0.112	0.112	0.103	0.118	0.081	0.081	0.073	0.085
Financial gains x Post	-0.852***	-0.852***	-0.845***	-0.832***	-0.832***	-0.826***	-0.792***	-0.820***	-0.316***	-0.323***	-0.299***	-0.283***
	0.108	0.108	0.106	0.106	0.106	0.106	0.097	0.11	0.076	0.078	0.07	0.077
Social norm x Post	0.018	0.018	0.04	0.038	0.038	0.02	0.015	0.064	-0.305***	-0.314***	-0.288***	-0.286***
	0.079	0.079	0.079	0.079	0.079	0.08	0.07	0.081	0.09	0.09	0.08	0.09
Intrinsic motivation x Post	-0.121*	-0.121*	-0.098	-0.1	-0.1	-0.088	-0.091	-0.062	-0.319***	-0.317***	-0.308***	-0.294***
	0.068	0.068	0.067	0.067	0.067	0.069	0.062	0.07	0.086	0.088	0.08	0.087
Social recognition x Post	-0.242***	-0.242***	-0.239***	-0.240***	-0.240***	-0.247***	-0.270***	-0.217**	-0.503***	-0.516***	-0.521***	-0.498***
	0.085	0.085	0.085	0.084	0.084	0.086	0.078	0.087	0.096	0.097	0.09	0.099
Public Good x Post	-0.052	-0.052	-0.106	-0.109	-0.109	-0.124	-0.153**	-0.071	-0.286***	-0.294***	-0.315***	-0.270***
	0.075	0.075	0.075	0.075	0.075	0.075	0.067	0.077	0.085	0.086	0.077	0.088
Indigent status				2.139***	2.139***	2.197***	2.215***	1.792***	1.412***	1.434***	1.425***	0.941**
				0.323	0.323	0.327	0.333	0.326	0.389	0.389	0.388	0.369
Frequency (-1)						-0.036				-0.022		
						0.038				0.037		
Billed amount (-1)							0.005***				0.005***	
							0				0	
Tariff rate (-1)								-0.053***				-0.053***
								0.003				0.003
Post x indigent									2.079***	2.059***	2.020***	2.187***
									0.235	0.238	0.224	0.268
Tips x indigent									0.142	0.14	0.197	0.077
									0.249	0.237	0.228	0.269
Graph x indigent									-1.033*	-0.806	-0.723	-1.063
									0.599	0.575	0.531	0.665
Financial gains x indigent									-1.006**	-1.016***	-0.922**	-0.781*
									0.403	0.392	0.377	0.434
Social norm x indigent									-0.506	-0.406	-0.367	-0.365
									0.323	0.324	0.307	0.336
Intrinsic motivation x indigent									-0.481	-0.507*	-0.413	-0.341

									0.295	0.298	0.279	0.323
Social recognition x indigent									-0.534*	-0.541*	-0.435	-0.607*
									0.301	0.3	0.279	0.32
Public Good x indigent									-0.585**	-0.574**	-0.508**	-0.555**
									0.268	0.276	0.256	0.267
Tips x indigent x Post									0.235	0.259	0.23	0.280*
									0.158	0.162	0.143	0.156
Graph x indigent x Post									-0.542*	-0.553*	-0.502*	-0.495
									0.324	0.334	0.293	0.321
Financial gains x indigent x Post									-0.114	-0.068	-0.073	-0.075
									0.241	0.252	0.224	0.235
Social norm x indigent x Post									0.566***	0.551***	0.479***	0.563***
									0.155	0.159	0.139	0.158
Intrinsic motivation x indigent x Post									0.243*	0.276*	0.253*	0.258*
									0.142	0.146	0.132	0.15
Social recognition x indigent x Post									0.567***	0.585***	0.540***	0.608***
									0.159	0.165	0.15	0.163
Public Good x indigent x Post									0.261*	0.251	0.231*	0.307**
									0.155	0.157	0.138	0.156
Constant	23.264***	23.264***	26.914***	26.259***	26.259***	26.275***	25.220***	27.275***	26.566***	26.586***	25.520***	27.613***
	0.066	0.066	0.252	0.28	0.28	0.275	0.315	0.257	0.284	0.279	0.315	0.261
Observations	2 074 219	2074219	2 074 219	2 074 219	2 074 219	2042709	2042709	1821003	2 074 219	2 042 709	2 042 709	1 821 003
Treated	1 769 214	1 769 214	1 769 214	1 769 214	1 769 214	1742722	1742722	1553673	1 769 214	1742722	1742722	1553673
Control	305 005	305 005	305 005	305 005	305 005	299987	299987	267330	305 005	299987	299987	267330
Clusters	672	672	672	672	672	672	672	672	672	672	672	672
Fpvalue	0	0	0	0	0	0	0	0	0	0	0	0
R-squared	0.012	0.012	0.074	0.074	0.074	0.076	0.093	0.088	0.078	0.079	0.097	0.092

Appendix E

Appendix to Chapter 5

E.1 Bénabou and Tirole's (2006) Model on Incentives and Prosocial Behaviour

Note: The explanation of this model as it relates to our study is taken from the work by Exley (2014) as well as Rosa Dias (2013).

According to Bénabou and Tirole (2006), the benefit of conserving water a is equal to the household's intrinsic motivation for conserving water v_a and for the reward v_y.

The level of a is incentivised at a rate y according to their intrinsic, extrinsic and image motivations and cost of conserving water (Exley, 2014). Preferences for how much the household values the public signal v_y leads to a utility of $(v_a + yv_y)a$. The cost to the household of conserving water is donated by $C(a)$ (Exley, 2014):

$$U(a, y) = (v_a + yv_y)a - C(a) \tag{E.1}$$

The reputational payoff from a, given y, is (Exley, 2014):

$$x[\gamma_a E(v_a|a, y) - \gamma_y E(v_y|a, y)] \tag{E.2}$$

with γ_a and $\gamma_y \geq 0$. $x{>}0$ is the measure of visibility of the household's water savings. We exogenously vary the visibility of x by allowing an opt-out in one treatment. γ_a and γ_y are the levels at which the household would like to appear prosocial and not image concerned, respectively (Exley, 2014). Image motivation is the combination of how prosocial or image concerned others believe the agent is based on the incentive given for conserving water a, which is weighted by the household's preference to appear prosocial - u_a and not image concerned - u_y given visibility of the household's water savings efforts. This is captured by $I(a, y)$:

$$I(a, y) = u_a E(v_a|a, y) - u_y E(v_y|a, y) \tag{E.3}$$

and entered in the utility maximization function with respect to a (Exley, 2014):

$$U(a, y) = (v_a + yv_y)a + I(a, y) - C(a) \tag{E.4}$$

This model helps to structure our hypotheses and questions at hand as we randomise the visibility of social recognition.

E.2 Treatments

Figure E.1: Tips

Figure E.2: Tips: Afrikaans language

WATER BESPARINGS WENKE

VINNIGE OPLOSSINGS
AKSIES WAT ONMIDDELIK GENEEM KAN WORD

Verkort storttyd

'n Standaard stortkop kan soveel as 16 liter water per minuut gebruik. Deur net jou storttyd met drie minute te verkort kan 48 liter per stort gespaar word. Vir 'n familie van 4 kan dit 'n besparing van 5760 liter (5.76 kiloliters) per maand wees.

Moenie krane oop vergeet nie

'n Lopende kraan kan soveel as 20 liter water per minuut mors. Draai die kraan toe terwyl jy tandeborsel, skeer of skottelgoed was. As jy daagliks 2 minute lank tandeborsel terwyl jy die kraan laat loop, kan jy 1200 liter (1.2 kiloliter) water per maand gebruik. Dit kan 4800 liter (4.8 kiloliter) wees vir 'n familie van 4. Verlaag jou verbruik tot 'n minimum deur net die kraan toe te draai.

Gebruik minder badwater

Wanneer jy jou bad net halfpad vol tap, bespaar jy tussen 40 en 75 liter per bad. 'n Besparing van 40 liter per bad vir 'n familie van 4 kan 'n besparing van 4800 liter per maand (4.8 kiloliter) wees.

Lekke moet dadelik herstel word

Lekkende krane, stortkoppe en toilette kan groot hoeveelhede water vermors. 'n Lekkende kraan kan tussen 30 – 60 liter water per dag vermors. Dit is 900 – 1800 liter (0.9 – 1.8 kiloliters) per maand! Onthou, alle lekke is nie altyd sigbaar nie.

Maak waterslim tuin

Hou by munisipale regulasies wanneer jy jou tuin natmaak. Onthou om outomatiese sproeiers af te skakel wanneer reën verwag word.

SLIM AANKOPE
SPANDEER MINDER EN SPAAR MEER

Gebruik 'n waterbesparende stortkop

'n Waterbesparende stortkop kan so min as 6 liter water per minuut gebruik. Deur oor te skakel van 'n gewone stortkop na 'n waterbesparende stortkop kan soveel as 10 liter water per minuut gespaar word. Dit beteken dat 'n familie van 4, 1200 liter (1.2 kiloliter) per minuut kan spaar sonder enige verandering in gedragspatrone.

Instaleer waterbesparende toestelle aan krane

Kraanlugverrykers, wat aan krane geskroef word verminder die vloei van water deurdat lug met die water vermeng word. Terwyl watervloei uit gewone krane tussen 20 – 30 liter per minuut is, kan hierdie waterbesparende toestelle die vloei verminder na so min as 6 liter per minuut.

Verminder watergebruik met elke toiletspoel

Ouer toilette kan soveel as 12 liter water per spoel gebruik. Deur jou huidige toilet te verander na 'n multi-spoel eenheid (vloeibrekende spoeleenheid), kan jy waterverbruik met halfeer met elke spoel. As 'n familie van vier die toilet 10 keer per dag spoel spaar dit 1800 liter (1.8 kiloliter) per maand.

Gebruik 'n swembadkombers

Watervlakke van swembaddens kan met 1 cm per dag sak tydens warm weer. Swembadkomberse kan verdamping met 90% verminder wat die water wat jy sou gebruik het om op te vul, spaar. Indien jou swembad met meer as 6 cm per week sak, moet daar 'n lek wees. Soek krake binne in die swembad. Onthou dat outomatiese opvullingstelsels nie toelaatbaar is nie.

Het jy geweet? 1 kiloliter = 1 000 liters

Vir navrae skakel 021 650 5186
weeksdae tussen 09:00 en 16:00

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Maak vooruitgang moontlik. Tesame.

Figure E.3: Intrinsic Motivation Message

HELP TO SAVE WATER THIS SUMMER!

- The City is launching a water savings initiative over the summer months when water usage normally increases.
- Please try to reduce consumption by 10% between November and April.
- As you used 34 kl this month, this means you need to keep your monthly consumption around 31 kl.
- You will be notified of how your household did in May.
- **Get saving today!**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure E.4: Intrinsic Motivation Message: Afrikaans language

HELP OM WATER TE BESPAAR HIERDIE SOMER!

- Die Stad loots 'n waterbesparingsprojek gedurende hierdie somer wanneer water verbruik gewoonlik styg.
- Probeer asseblief waterverbruik met 10% verminder vanaf November tot April.
- Aangesien jy hierdie maand 34 kl verbruik het, beteken dit dat jy jou verbruik maandeliks rondom 31 kl sal moet hou.
- Jy sal in kennis gestel word van jou huishouding se prestasie in Meimaand.
- **Begin vandag bespaar!**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

Figure E.5: Public Recognition Message

BE PUBLICLY RECOGNISED FOR SAVING WATER!

- The City is launching a water savings initiative over the summer months when water usage normally increases.
- Please try to reduce consumption by 10% between November and April.
- As you used 34 kl this month, this means you need to keep your monthly consumption around 31 kl.
- The City will **publicly recognise** the achievement of all water-wise households by **publishing your name and suburb on the City's website.**
- You will be notified of how your household did in May.
- **Get saving today!**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure E.6: Public Recognition Message: Afrikaans language

KRY PUBLIEKE ERKENNING VIR WATERBESPARING

- Die Stad loots 'n waterbesparingsprojek gedurende hierdie somer wanneer water verbruik gewoonlik styg.
- Probeer asseblief waterverbruik met 10% verminder vanaf November tot April.
- Aangesien jy hierdie maand 34 kl verbruik het beteken dit dat jy jou verbruik maandeliks rondom 31 kl sal moet hou.
- Die Stad sal die prestasie van alle huishoudings wat water bespaar aan die **publiek** bekend maak deur jou **naam en woonbuurt op die Stad se webblad te publiseer.**
- Jy sal in kennis gestel word van jou huishouding se prestasie in Meimaand.
- **Begin vandag bespaar!**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

Figure E.7: Social Recognition: Opt Out

BE PUBLICLY RECOGNISED
FOR SAVING WATER!

- The City is launching a water savings initiative over the summer months when water usage normally increases.
- Please try to reduce consumption by 10% between November and April.
- As you used 34 kl this month, this means you need to keep your monthly consumption around 31 kl.
- The City will **publicly recognise** the achievement of all water-wise households by **publishing your name and suburb on the City's website.**
- You will be notified of how your household did in May.
- **Get saving today!**
- **If you prefer not to have your name published, please contact: 021 650 5186**

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure E.8: Social Recognition: Opt Out: Afrikaans language

KRY **PUBLIEKE ERKENNING**
VIR WATERBESPARING

- Die Stad loots 'n waterbesparingsprojek gedurende hierdie somer wanneer water verbruik gewoonlik styg.
- Probeer asseblief waterverbruik met 10% verminder vanaf November tot April.
- Aangesien jy hierdie maand 34 kl verbruik het beteken dit dat jy jou verbruik maandeliks rondom 31 kl sal moet hou.
- Die Stad sal die prestasie van alle huishoudings wat water bespaar aan die **publiek** bekend maak deur jou **naam en woonbuurt op die Stad se webblad te publiseer.**
- Jy sal in kennis gestel word van jou huishouding se prestasie in Meimaand.
- **Begin vandag bespaar!**
- **Indien jy nie wil hê dat jou naam gepubliseer word nie, kontak asseblief 021 650 5186.**

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

Figure E.9: May Insert for Winners in both Social Recognition treatments

BE PUBLICLY RECOGNISED
FOR SAVING WATER!

- Over the last six months your household participated in our water savings initiative.
- **Congratulations on being one of the biggest savers over these past six months!**
- While water consumption increases during the summer months, your conservation efforts mean that your household succeeded in meeting the goal of reducing consumption by at least 10% over the last six months.
- Thanks for participating in this initiative and for all your efforts to conserve water.
- We will publish the names of the top savers by suburb on the Water and Sanitation Department's Website: **www.capetown.gov.za/en/Water/Pages/Saving-water**
- If you prefer not to have your name published, please contact: 021 650 5186

Not sure how to reduce your consumption?
The tips on the back show you how!

Figure E.10: May Insert for Winners in both Social Recognition treatments: Afrikaans language

KRY **PUBLIEKE ERKENNING**
VIR WATERBESPARING

- Jou huishouding het die afgelope ses maande aan ons waterbesparingsinisiatief deelgeneem.
- **Baie geluk! Jou huishouding was een van die grootste bespaarders die afgelope ses maande!**
- Hoewel water verbruik toeneem gedurende die somer maande, het jul moeite met besparing daartoe gelei dat jul huishouding suksesvol was om die doelwit te bereik om verbruik met 10% te verminder in the laaste 6 maande!
- Baie dankie dat u deelgeneem het aan hierdie inisiatief en vir u pogings om water te bespaar.
- Ons sal die name van die top bespaardes in elke buurt op die webblad van die Department van Water en Sanitasie publiseer: **www.capetown.gov.za/en/Water/Pages/Saving-water**
- Indien u nie wil hê dat u naam gepubliseer word nie, kontak asseblief 021 650 5186.

Nie seker hoe om jou verbruik te verminder nie?
Die wenke aan die agterkant vertel jou hoe!

E.3 Hypotheses

Figure E.11: Intrinsic Motivation Hypothesis I

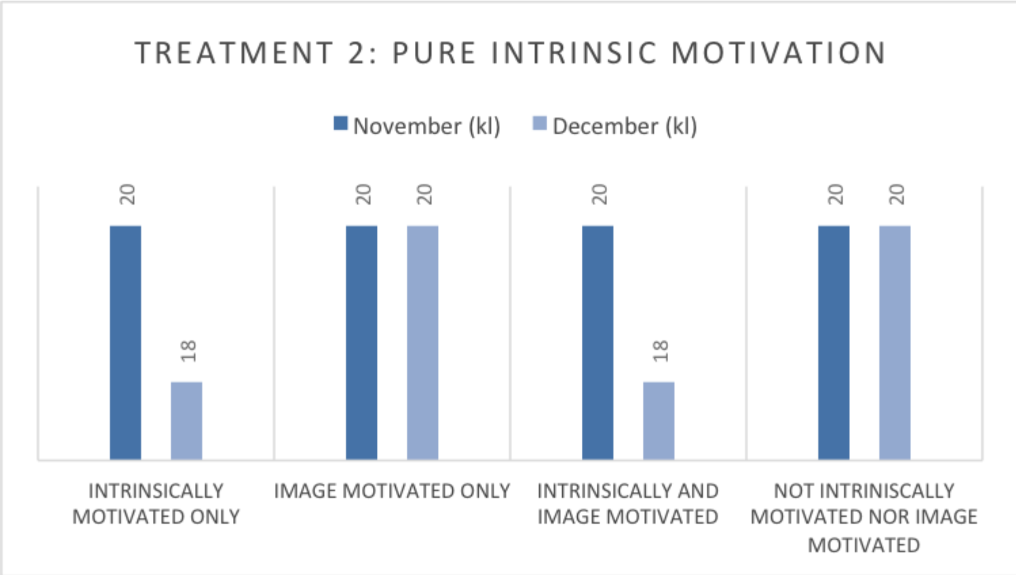


Figure E.12: Social Recognition Hypothesis II

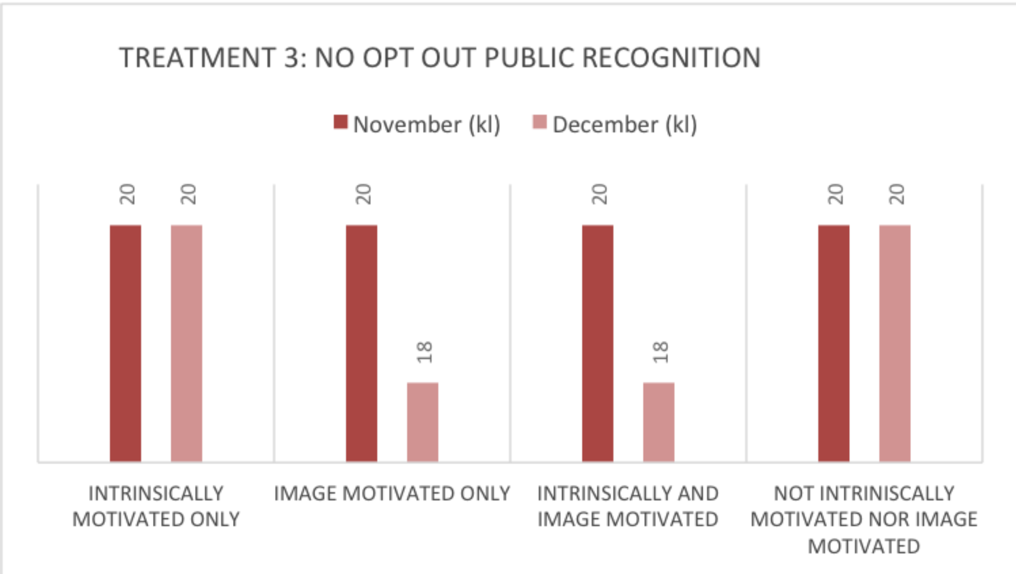
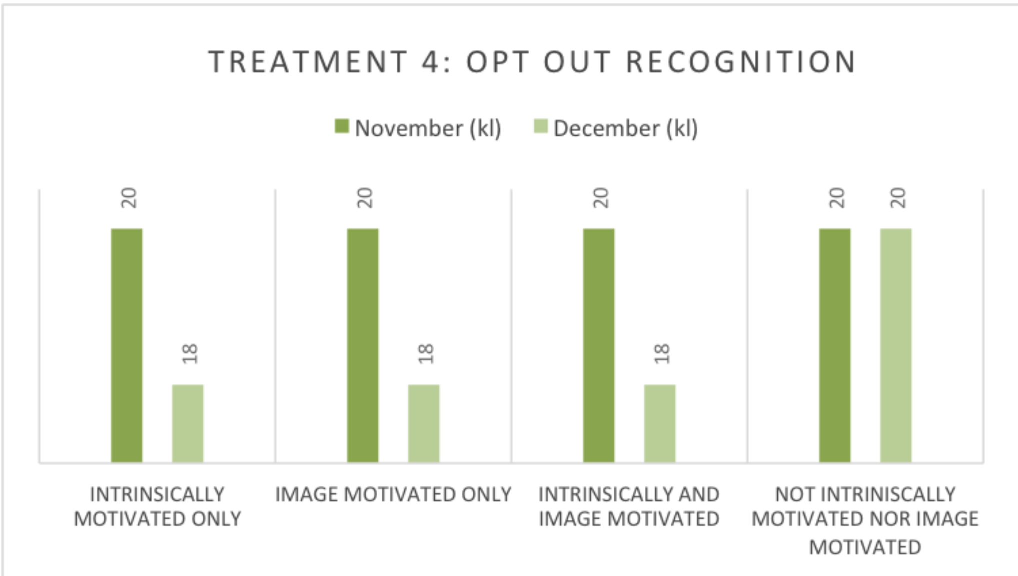


Figure E.13: Social Recognition Hypothesis III



E.4 Robustness checks

Table E.1: DiD Once off results (Dec 2015 - Jan 2016)

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VII Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)
Tips	0.088	0.085	0.088	0.092	0.088	0.093	0.076	0.112	0.145	0.162*	0.152*
	0.085	0.083	0.083	0.075	0.083	0.075	0.066	0.074	0.091	0.083	0.089
Intrinsic	0.062	0.085	0.097	0.027	0.097	0.026	-0.008	0.035	0.033	0.058	0.051
	0.098	0.096	0.096	0.087	0.096	0.087	0.068	0.086	0.11	0.091	0.107
Image Motivation	0.324*	0.316*	0.318*	0.289*	-0.008	-0.051	-0.033	-0.04	0.14	0.1	0.154
	0.17	0.169	0.17	0.165	0.109	0.099	0.083	0.097	0.149	0.143	0.146
SR Opt Out	0.077	0.093	0.102	-0.007	0.101	-0.007	0.055	0.008	0.04	0.149	0.057
	0.088	0.086	0.086	0.083	0.086	0.083	0.072	0.081	0.102	0.09	0.099
Post	-2.022***	-2.028***	-2.031***	-1.956***	-2.031***	-1.957***	-2.199***	-1.954***	-2.585***	-2.706***	-2.592***
	0.193	0.193	0.193	0.198	0.193	0.198	0.206	0.2	0.243	0.273	0.244
Tips x Post	-0.059	-0.061	-0.062	-0.074	-0.063	-0.074	-0.065	-0.093	-0.081	-0.106	-0.084
	0.09	0.09	0.09	0.088	0.09	0.088	0.083	0.089	0.11	0.107	0.11
Intrinsic x Post	0.055	0.055	0.055	0.064	0.055	0.064	0.046	0.043	0.03	-0.042	0.011
	0.1	0.1	0.1	0.098	0.1	0.098	0.087	0.101	0.122	0.11	0.123
Image Motivation x Post	-0.575***	-0.561***	-0.554***	-0.590***	-0.245**	-0.268**	-0.327***	-0.271**	-0.536***	-0.555***	-0.537***
	0.185	0.185	0.186	0.184	0.123	0.123	0.119	0.123	0.169	0.173	0.169
SR Opt Out x Post	-0.046	-0.05	-0.051	-0.008	-0.051	-0.008	-0.101	-0.026	-0.056	-0.200*	-0.061
	0.091	0.09	0.09	0.087	0.09	0.087	0.084	0.087	0.104	0.106	0.105
QPV1		-4.157***	-3.587***	-2.200***	-3.591***	-2.204***	-1.602***	-2.108***	-2.213***	-1.613***	-2.116***
		0.572	0.565	0.364	0.567	0.365	0.285	0.353	0.367	0.286	0.355
QPV2		-4.366***	-3.966***	-2.358***	-3.972***	-2.366***	-1.721***	-2.252***	-2.355***	-1.711***	-2.241***
		0.544	0.521	0.357	0.522	0.358	0.292	0.345	0.36	0.293	0.347
QPV3		-3.813***	-3.807***	-2.221***	-3.807***	-2.222***	-1.524***	-2.110***	-2.223***	-1.529***	-2.111***
		0.42	0.41	0.282	0.41	0.282	0.228	0.272	0.282	0.228	0.272
QPV4		-2.743***	-2.766***	-1.626***	-2.763***	-1.622***	-1.026***	-1.537***	-1.624***	-1.030***	-1.539***
		0.272	0.268	0.18	0.268	0.18	0.145	0.173	0.18	0.145	0.173
Indigent status			-0.875***	-0.604***	-0.865***	-0.593***	-0.439***	-0.560***	-1.544***	-1.222***	-1.518***
			0.194	0.158	0.195	0.159	0.133	0.154	0.268	0.247	0.266
Less November				0.621***		0.621***	0.134***	0.579***	0.622***	0.135***	0.579***
				0.009		0.009	0.011	0.009	0.009	0.011	0.009
Frequency (-1)					1.535**	1.636**	0.973	1.583**	1.593**	0.944	1.542**
					0.712	0.711	0.752	0.707	0.709	0.753	0.704

Billed amount (-1)							0.026***			0.026***	
							0.001			0.001	
Tariff rate (-1)								0.159***			0.160***
								0.004			0.004
Post x indigent									1.876***	1.531***	1.908***
									0.344	0.335	0.348
Tips x indigent									-0.153	-0.269**	-0.118
									0.161	0.129	0.159
Intrinsic x indigent									0.154	-0.033	0.132
									0.169	0.128	0.165
Image Motivation x indigent									-0.451	-0.313	-0.462
									0.3	0.31	0.301
SR Opt out x indigent									-0.028	-0.188	-0.032
									0.179	0.147	0.176
Tips x indigent x Post									0.025	0.141	-0.021
									0.178	0.158	0.18
Intrinsic x indigent x Post									-0.238	-0.035	-0.248
									0.181	0.161	0.184
Image Motivation x indigent x Post									0.560*	0.483	0.557*
									0.301	0.324	0.306
SR Opt Out x indigent x Post									-0.06	0.129	-0.095
									0.196	0.175	0.193
Constant	13.325***	16.376***	16.495***	8.904***	16.496***	8.903***	11.324***	7.407***	9.200***	11.557***	7.704***
	0.135	0.377	0.373	0.289	0.373	0.288	0.259	0.277	0.304	0.281	0.295
Observations	281 373	281 373	281 373	272 452	281 373	272 452	263 265	271 049	272 452	263 265	271 049
Treated	218 061	218 061	218 061	212 552	218 061	212 552	205 343	211 486	212 552	205 343	211 486
Treat1	65 014	65 014	65 014	62 171	65 014	62 171	60 044	61 862	62 171	60 044	61 862
Treat2	49 605	49 605	49 605	48 871	49 605	48 871	47 224	48 630	48 871	47 224	48 630
Treat3	48 553	48 553	48 553	47 385	48 553	47 385	45 824	47 150	47 385	45 824	47 150
Treat4	54 889	54 889	54 889	54 125	54 889	54 125	52 251	53 844	54 125	52 251	53 844
Control	63 312	63 312	63 312	59 900	63 312	59 900	57 922	59 563	59 900	57 922	59 563
Clusters	652	652	652	652	652	652	652	652	652	652	652
Fpvalue	0.036	0.042	0.047	0.025	0.259	0.16	0.041	0.185	0.023	0.013	0.026
R-squared	0.475	0.479	0.479	0.582	0.48	0.583	0.689	0.591	0.584	0.69	0.593

Notes: Regressions include tariff block, month and suburb fixed effects
Standard errors are clustered at the suburb level and are presented in parenthesis

Table E.2: Pooled regressions (monthly consumption) Dec 2014 - April 2015

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)	XII Monthly consumption (kl)	XIII Monthly consumption (kl)	IXV Monthly consumption (kl)	XV Monthly consumption (kl)	XVI Monthly consumption (kl)
Tips	-0.054	-0.062	-0.067	-0.067	-0.063	-0.067	-0.063	-0.063	-0.058	-0.074	-0.074	-0.075	-0.059	-0.088
	0.059	0.063	0.063	0.063	0.054	0.063	0.054	0.054	0.042	0.053	0.065	0.065	0.049	0.063
Intrinsic Motivation	-0.099	-0.119*	-0.112*	-0.109*	-0.196***	-0.109*	-0.195***	-0.195***	-0.170***	-0.207***	-0.225***	-0.224***	-0.192***	-0.245***
	0.063	0.062	0.062	0.062	0.056	0.062	0.056	0.056	0.044	0.054	0.067	0.067	0.054	0.064
Image Motivation	-0.184***	-0.124**	-0.130**	-0.128**	-0.182***	-0.053	-0.132**	-0.132**	-0.116**	-0.114**	-0.224***	-0.226***	-0.205***	-0.205***
	0.055	0.055	0.055	0.055	0.053	0.057	0.056	0.056	0.046	0.054	0.064	0.064	0.051	0.06
SR Opt Out	-0.091	-0.1	-0.095	-0.093	-0.173***	-0.093	-0.173***	-0.175***	-0.145***	-0.176***	-0.224***	-0.226***	-0.177***	-0.219***
	0.058	0.063	0.063	0.063	0.052	0.063	0.052	0.052	0.041	0.054	0.065	0.065	0.051	0.062
Pre intervention monthly consumption		0.220***	0.218***	0.218***	0.146***	0.218***	0.146***	0.146***	0.122***	0.139***	0.146***	0.146***	0.122***	0.139***
		0.015	0.015	0.015	0.011	0.015	0.011	0.011	0.01	0.012	0.011	0.011	0.01	0.012
Property Value Q1			-1.860***	-1.719***	-0.843***	-1.721***	-0.845***	-0.846***	-0.643***	-0.729***	-0.843***	-0.844***	-0.641***	-0.727***
			0.331	0.338	0.225	0.337	0.225	0.225	0.178	0.199	0.225	0.224	0.178	0.199
Property Value Q2			-2.187***	-2.090***	-1.041***	-2.090***	-1.042***	-1.044***	-0.790***	-0.933***	-1.041***	-1.044***	-0.790***	-0.933***
			0.306	0.302	0.222	0.302	0.222	0.222	0.171	0.186	0.222	0.222	0.171	0.186
Property Value Q3			-2.045***	-2.046***	-1.017***	-2.046***	-1.017***	-1.019***	-0.750***	-0.938***	-1.018***	-1.019***	-0.750***	-0.938***
			0.229	0.226	0.17	0.226	0.171	0.171	0.127	0.152	0.171	0.17	0.127	0.152
Property Value Q4			-1.535***	-1.542***	-0.818***	-1.543***	-0.819***	-0.820***	-0.593***	-0.771***	-0.819***	-0.821***	-0.593***	-0.772***
			0.15	0.149	0.111	0.149	0.111	0.111	0.086	0.103	0.111	0.111	0.086	0.103
Indigent status				-0.219*	-0.032	-0.220*	-0.032	-0.033	-0.032	0.025	-0.141	-0.143	-0.116	-0.085
				0.121	0.091	0.121	0.091	0.091	0.076	0.084	0.106	0.106	0.086	0.102
10% target*					0.549***		0.549***	0.549***	0.357***	0.521***	0.549***	0.549***	0.357***	0.521***
					0.01		0.01	0.01	0.006	0.01	0.01	0.01	0.006	0.01
Late Receiver						-0.451***	-0.309**	-0.009	-0.391***	-0.590***	-0.306**	-0.006	-0.388***	-0.588***
						0.138	0.149	0.164	0.13	0.137	0.149	0.164	0.13	0.136
Frequency (-1)								0.299***				0.299***		
								0.066				0.066		

Billed amount (-1)									0.009***				0.009***	
									0				0	
Tariff rate (-1)										0.146***				0.146***
										0.005				0.005
Tips x Indigent											0.037	0.038	0.004	0.044
											0.12	0.119	0.096	0.12
Intrinsic Motivation x Indigent											0.094	0.094	0.072	0.118
											0.114	0.114	0.094	0.114
Image Motivation x Indigent											0.272**	0.274**	0.257***	0.267**
											0.115	0.114	0.094	0.116
SR Opt Out x Indigent											0.155	0.155	0.1	0.133
											0.11	0.11	0.086	0.117
Constant	13.003***	7.782***	9.334***	9.364***	3.865***	9.353***	3.858***	3.574***	5.472***	2.390***	3.893***	3.608***	5.498***	2.425***
	0.071	0.216	0.281	0.283	0.191	0.283	0.191	0.197	0.175	0.177	0.193	0.198	0.177	0.179
TB baseline	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	742 968	567 810	567 810	567 810	550 768	567 810	550 768	550 768	550 768	500 511	550 768	550 768	550 768	500 511
Treated	579 962	443 893	443 893	443 893	432 596	443 893	432 596	432 596	432 596	393 081	432 596	432 596	432 596	393 081
Tips	168 577	128 864	128 864	128 864	122 906	128 864	122 906	122 906	122 906	111 546	122 906	122 906	122 906	111 546
Intrinsic Motivation	127 391	97 045	97 045	97 045	95 712	97 045	95 712	95 712	95 712	86 957	95 712	95 712	95 712	86 957
Image Motivation	143 083	109 929	109 929	109 929	107 325	109 929	107 325	107 325	107 325	97 586	107 325	107 325	107 325	97 586
SR Opt Out	140 911	108 055	108 055	108 055	106653	108 055	106 653	106 653	106 653	96 992	106 653	106 653	106 653	96 992
Control	163 006	123 917	123 917	123 917	118 172	123 917	118 172	118 172	118 172	107 430	118 172	118 172	118 172	107 430
Clusters	652	649	649	649	649	649	649	649	649	649	649	649	649	649
Fpvalue	0.015	0.145	0.15	0.163	0	0.437	0	0	0	0	0	0	0	0
R-squared	0.426	0.509	0.51	0.51	0.575	0.51	0.575	0.575	0.609	0.585	0.575	0.575	0.609	0.585

Table E.3: Pooled regressions: Relative consumption (Dec 2014 - April 2015)

	I Relative consumption (kl)	II Relative consumption (kl)	III Relative consumption (kl)	IV Relative consumption (kl)	V Relative consumption (kl)	VIII Relative consumption (kl)	IX Relative consumption (kl)	X Relative consumption (kl)	XI Relative consumption (kl)	XII Relative consumption (kl)	XIII Relative consumption (kl)	XIV Relative consumption (kl)
Tips	-0.009**	-0.009**	-0.009**	-0.009**	-0.009**	-0.009**	-0.009**	-0.009***	-0.009**	-0.009**	-0.008**	-0.009**
	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004
Intrinsic Motivation	-0.010***	-0.011***	-0.012***	-0.012***	-0.012***	-0.012***	-0.011***	-0.012***	-0.009**	-0.009**	-0.008**	-0.010**
	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.004	0.004	0.004	0.004
Image Motivation	-0.017***	-0.009**	-0.009**	-0.010**	-0.009**	-0.009**	-0.009**	-0.009**	-0.012***	-0.013***	-0.012***	-0.013***
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
SR Opt Out	-0.010***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.010***	-0.010**	-0.011***	-0.012***	-0.010***	-0.011***
	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Property Value Q1		0.139***	0.107***	0.119***	0.107***	0.119***	0.126***	0.111***	0.119***	0.119***	0.126***	0.111***
		0.015	0.014	0.015	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Property Value Q2		0.086***	0.064***	0.077***	0.064***	0.077***	0.086***	0.068***	0.077***	0.077***	0.086***	0.068***
		0.011	0.009	0.011	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Property Value Q3		0.053***	0.053***	0.065***	0.053***	0.065***	0.074***	0.059***	0.065***	0.065***	0.074***	0.059***
		0.008	0.008	0.008	0.008	0.008	0.009	0.008	0.008	0.008	0.009	0.008
Property Value Q4		0.025***	0.026***	0.034***	0.026***	0.034***	0.041***	0.031***	0.034***	0.034***	0.041***	0.031***
		0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Indigent status			0.050***	0.050***	0.050***	0.050***	0.051***	0.050***	0.049***	0.049***	0.051***	0.049***
			0.007	0.008	0.007	0.008	0.008	0.008	0.01	0.01	0.01	0.01
10% target*				0.005***		0.005***	0	0.007***	0.005***	0.005***	0	0.007***
				0.001		0.001	0	0.001	0.001	0.001	0	0.001
Late Receiver					-0.002	0	-0.004	-0.007	-0.002	0	-0.004	-0.007
					0.01	0.011	0.01	0.009	0.01	0.011	0.009	0.009
Frequency (-1)						0.003				0.003		
						0.004				0.004		
Billed amount (-1)							0.000***				0.000***	
							0				0	
Tariff rate (-1)								-0.006***				-0.006***
								0				0

Tips x Indigent									0	0	-0.001	-0.002
									0.008	0.008	0.008	0.008
Intrinsic Motivation x Indigent									-0.007	-0.007	-0.007	-0.006
									0.008	0.008	0.008	0.008
Image Motivation x Indigent									0.009	0.009	0.009	0.01
									0.009	0.009	0.009	0.01
SR Opt Out x Indigent									0.002	0.002	0	0.002
									0.009	0.009	0.009	0.01
Constant	0.011	-0.073***	-0.080***	-0.144***	-0.080***	-0.146***	-0.110***	-0.094***	-0.143***	-0.146***	-0.110***	-0.093***
	0.007	0.012	0.012	0.018	0.012	0.019	0.016	0.016	0.018	0.02	0.016	0.017
TB baseline	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	567 801	567 801	567 801	550 759	567 801	550 759	550 759	500 504	550 759	550 759	550 759	500 504
Treated	443 887	443 887	443 887	432 590	443 887	432 590	432 590	393 077	432 590	432 590	432 590	393 077
Tips	128 864	128 864	128 864	122 906	128 864	122 906	122 906	111 546	122 906	122 906	122 906	111 546
Intrinsic Motivation	97 041	97 041	97 041	95 708	97 041	95 708	95 708	86 955	95 708	95 708	95 708	86 955
Image Motivation	109 927	109 927	109 927	107 323	109 927	107 323	107 323	97 584	107 323	107 323	107 323	97 584
SR Opt Out	108 055	108 055	108 055	106 653	108 055	106 653	106 653	96 992	106 653	106 653	106 653	96 992
Control	123 914	123 914	123 914	118 169	123 914	118 169	118 169	107 427	118 169	118 169	118 169	107 427
Clusters	649	649	649	649	649	649	649	649	649	649	649	649
Fpvalue	0.001	0.018	0.011	0.011	0.011	0.011	0.014	0.016	0.022	0.022	0.042	0.029
R-squared	0.029	0.034	0.035	0.039	0.035	0.039	0.049	0.048	0.039	0.039	0.049	0.048

Table E.4: Pooled regressions using Daily Average (April 2014 - May 2015)

	I Daily average (kl)	II Daily average (kl)	III Daily average (kl)	IV Daily average (kl)	V Daily average (kl)	VI Daily average (kl)	VIII Daily average (kl)	IX Daily average (kl)	X Daily average (kl)	XI Daily average (kl)	XII Daily average (kl)	XIII Daily average (kl)	XIV Daily average (kl)	XV Daily average (kl)
Tips	0	-0.002	-0.002	-0.002	-0.001	-0.002	-0.001	-0.001	0	-0.001	-0.001	-0.001	0	-0.002
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Intrinsic Motivation	-0.001	-0.004*	-0.004	-0.004	-0.004*	-0.004	-0.004*	-0.004*	-0.003	-0.005**	-0.004	-0.004	-0.002	-0.005
	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Image Motivation	-0.007***	-0.003	-0.004	-0.003	-0.004	-0.005**	0.006***	0.006***	0.006***	0.006***	0.012***	-0.012***	-0.011***	-0.011***
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
SR Opt Out	-0.003	-0.004*	-0.004*	-0.004*	-0.005**	-0.004*	-0.005**	-0.005**	-0.004*	-0.006***	-0.006**	-0.006**	-0.004	-0.007**
	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003
Pre intervention mean consumption		0.013***	0.013***	0.013***	0.008***	0.013***	0.008***	0.008***	0.006***	0.007***	0.008***	0.008***	0.006***	0.007***
		0.001	0.001	0.001	0	0.001	0	0	0	0	0	0	0	0
Property Value Q1			0.034***	0.028***	-0.012*	0.028***	-0.012*	-0.012*	-0.009	-0.01	-0.012*	-0.012*	-0.009	-0.01
			0.009	0.009	0.007	0.009	0.007	0.007	0.006	0.007	0.007	0.007	0.006	0.007
Property Value Q2			0.043***	0.039***	-0.018**	0.039***	-0.018**	0.018***	-0.013**	-0.015**	-0.018**	-0.018**	-0.013**	-0.015**
			0.009	0.008	0.007	0.008	0.007	0.007	0.006	0.007	0.007	0.007	0.006	0.007
Property Value Q3			0.037***	0.037***	-0.016**	0.037***	-0.016**	-0.016**	-0.010*	-0.014**	-0.016**	-0.016**	-0.010*	-0.014**
			0.007	0.007	0.006	0.007	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.006
Property Value Q4			0.027***	0.028***	0.014***	-0.028***	0.014***	0.014***	-0.008**	-0.013***	-0.014***	-0.014***	-0.008**	-0.013***
			0.005	0.005	0.004	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Indigent status				0.011***	-0.008**	-0.011***	-0.008**	-0.008**	-0.010***	-0.007**	-0.013***	-0.013***	-0.013***	-0.011***
				0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.004	0.004	0.004	0.004
10% target*					0.017***		0.017***	0.017***	0.010***	0.017***	0.017***	0.017***	0.010***	0.017***
					0		0	0	0	0	0	0	0	0
Late Receiver						0.010**	0.015***	0.020***	0.014***	0.015***	0.016***	0.020***	0.014***	0.016***
						0.004	0.004	0.005	0.004	0.004	0.004	0.005	0.003	0.004
Frequency (-1)								0.005**				0.005**		
								0.002				0.002		
Billed amount (-1)									0.000***				0.000***	

									0				0	
Tariff rate (-1)										0.004***				0.004***
										0				0
Tips x Indigent											0.002	0.002	0	0.001
											0.005	0.005	0.004	0.005
Intrinsic Motivation x Indigent											0	0	-0.002	0.001
											0.004	0.004	0.004	0.004
Image Motivation x Indigent											0.015***	0.015***	0.013***	0.014***
											0.004	0.004	0.004	0.004
SR Opt Out x Indigent											0.005	0.005	0.002	0.004
											0.004	0.004	0.003	0.004
Constant	0.428***	0.256***	0.286***	0.288***	0.168***	0.288***	0.168***	0.164***	0.249***	0.140***	0.170***	0.165***	0.250***	0.141***
	0.003	0.008	0.01	0.01	0.008	0.01	0.008	0.008	0.007	0.007	0.008	0.008	0.007	0.007
TB baseline	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	742 968	681 603	681 603	681 603	658 839	681 603	658 839	658 839	658 839	585 855	658 839	658 839	658 839	585 855
Treated	579 962	532 318	532 318	532 318	517 420	532 318	517 420	517 420	517 420	460 076	517 420	517 420	517 420	460 076
Tips	168 577	154 477	154 477	154 477	146 454	154 477	146 454	146 454	146 454	130 220	146 454	146 454	146 454	130 220
Intrinsic Motivation	127 391	116 587	116 587	116 587	114 925	116 587	114 925	114 925	114 925	102 145	114 925	114 925	114 925	102 145
Image Motivation	143 083	131 871	131 871	131 871	128 425	131 871	128 425	128 425	128 425	114 124	128 425	128 425	128 425	114 124
SR Opt Out	140 911	129 383	129 383	129 383	127 616	129 383	127 616	127 616	127 616	113 587	127 616	127 616	127 616	113 587
Control	163 006	149 285	149 285	149 285	141 419	149 285	141 419	141 419	141 419	125 779	141 419	141 419	141 419	125 779
Clusters	652	649	649	649	649	649	649	649	649	649	649	649	649	649
Fpvalue	0.016	0.26	0.291	0.321	0.049	0.142	0.006	0.006	0.008	0.004	0.001	0.001	0.001	0.001
R-squared	0.259	0.317	0.318	0.318	0.351	0.318	0.351	0.351	0.379	0.359	0.351	0.351	0.379	0.359

Table E.5: DiD (no fixed effects, no trend)

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)	XII Monthly consumption (kl)	XIII Monthly consumption (kl)	XIV Monthly consumption (kl)
Tips	0.047	0.037	0.038	0.05	0.038	0.05	0.051	0.049	0.048	0.132*	0.144*	0.116**	0.134*
	0.081	0.08	0.08	0.064	0.08	0.064	0.066	0.046	0.064	0.079	0.081	0.058	0.079
Intrinsic Motivation	0.042	0.062	0.067	-0.046	0.067	-0.046	-0.064	-0.048	-0.051	0.052	0.048	0.046	0.04
	0.085	0.084	0.084	0.074	0.084	0.074	0.074	0.051	0.072	0.094	0.096	0.067	0.091
Image Motivation	0.068	0.032	0.035	-0.006	0.072	0.005	0.003	0.064	0.049	0.133	0.142	0.156**	0.189**
	0.086	0.086	0.086	0.076	0.09	0.081	0.083	0.056	0.08	0.097	0.098	0.068	0.096
SR Opt Out	0.057	0.069	0.072	-0.044	0.072	-0.044	-0.045	-0.011	-0.036	0.006	0.013	0.038	0.014
	0.077	0.075	0.075	0.072	0.075	0.072	0.073	0.049	0.07	0.086	0.087	0.062	0.084
Post	-1.623***	-1.678***	-1.674***	-1.659***	-1.675***	-1.659***	-1.764***	-2.159***	-1.518***	-2.340***	-2.460***	-2.780***	-2.230***
	0.13	0.129	0.129	0.134	0.129	0.134	0.135	0.117	0.146	0.134	0.128	0.13	0.14
Tips x Post	-0.109	-0.103	-0.103	-0.102	-0.103	-0.102	-0.103	-0.108**	-0.112	-0.214***	-0.227***	-0.186***	-0.228***
	0.074	0.074	0.074	0.07	0.074	0.07	0.071	0.049	0.073	0.079	0.08	0.057	0.085
Intrinsic x Post	-0.08	-0.06	-0.059	-0.042	-0.059	-0.042	-0.027	-0.042	-0.037	-0.291***	-0.287***	-0.253***	-0.272***
	0.071	0.072	0.072	0.069	0.072	0.069	0.071	0.051	0.072	0.088	0.09	0.067	0.09
Image Motivation x Post	-0.226***	-0.224***	-0.223***	-0.224***	-0.219***	-0.222***	-0.223***	-0.297***	-0.222**	-0.509***	-0.518***	-0.533***	-0.517***
	0.083	0.082	0.082	0.082	0.082	0.082	0.084	0.062	0.086	0.091	0.092	0.073	0.095
SR Opt Out x Post	-0.121	-0.107	-0.106	-0.08	-0.106	-0.08	-0.08	-0.087*	-0.08	-0.247***	-0.254***	-0.214***	-0.240***
	0.074	0.073	0.073	0.074	0.073	0.074	0.074	0.052	0.078	0.08	0.08	0.06	0.084
Property Value Q1		-4.316***	-4.058***	-2.689***	-4.059***	-2.689***	-2.669***	-1.885***	-2.434***	-2.670***	-2.652***	-1.871***	-2.402***
		0.589	0.563	0.342	0.563	0.342	0.336	0.228	0.321	0.345	0.339	0.231	0.325
Property Value Q2		-4.594***	-4.415***	-2.837***	-4.415***	-2.837***	-2.824***	-1.940***	-2.627***	-2.816***	-2.802***	-1.921***	-2.594***
		0.553	0.525	0.351	0.525	0.351	0.347	0.233	0.325	0.352	0.349	0.234	0.326
Property Value Q3		-4.099***	-4.099***	-2.548***	-4.099***	-2.548***	-2.526***	-1.642***	-2.398***	-2.538***	-2.518***	-1.635***	-2.380***
		0.418	0.413	0.275	0.413	0.275	0.272	0.18	0.255	0.275	0.272	0.18	0.255
Property Value Q4		-2.937***	-2.949***	-1.829***	-2.950***	-1.830***	-1.812***	-1.126***	-1.726***	-1.827***	-1.810***	-1.126***	-1.720***
		0.277	0.276	0.181	0.276	0.181	0.178	0.12	0.164	0.181	0.178	0.12	0.164

Indigent status			-0.409**	-0.155	-0.410**	-0.155	-0.149	0.02	-0.17	-1.351***	-1.336***	-1.089***	-1.424***
			0.193	0.154	0.193	0.154	0.154	0.129	0.141	0.221	0.224	0.185	0.224
10% target*				0.621***		0.621***	0.622***	0.337***	0.566***	0.621***	0.622***	0.338***	0.566***
				0.011		0.011	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Late Receiver					-0.221*	-0.062	-0.04	-0.185**	-0.552***	-0.071	-0.041	-0.189**	-0.555***
					0.128	0.123	0.129	0.091	0.117	0.121	0.127	0.089	0.116
Frequency (-1)							0.033				0.045		
							0.039				0.039		
Billed amount (-1)								0.016***				0.016***	
								0				0	
Tariff rate (-1)									0.204***				0.203***
									0.004				0.004
Post x indigent										2.076***	2.038***	1.911***	2.170***
										0.224	0.229	0.189	0.255
Tips x indigent										-0.252*	-0.293**	-0.213**	-0.269**
										0.131	0.131	0.085	0.125
Intrinsic x indigent										-0.054	-0.092	-0.059	-0.03
										0.149	0.148	0.101	0.147
Image Motivation x indigent										-0.257*	-0.290*	-0.162	-0.290*
										0.155	0.162	0.113	0.156
SR Opt out x indigent										-0.021	-0.048	-0.032	-0.019
										0.15	0.154	0.105	0.148
Tips x indigent x Post										0.344**	0.386**	0.245**	0.358**
										0.152	0.154	0.101	0.158
Intrinsic x indigent x Post										0.273*	0.311**	0.208**	0.225
										0.143	0.143	0.105	0.155
Image Motivation x indigent x Post										0.596***	0.630***	0.470***	0.620***
										0.161	0.168	0.124	0.174
SR Opt Out x indigent x Post										0.238	0.267	0.154	0.218
										0.171	0.173	0.119	0.18
Constant	14.846***	21.597***	21.654***	14.175***	21.656***	14.176***	14.197***	15.622***	12.218***	14.531***	14.548***	15.942***	12.589***
	0.082	0.456	0.46	0.366	0.459	0.366	0.363	0.348	0.33	0.376	0.371	0.358	0.336
TB baseline	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Month fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1 380 281	1 380 281	1 380 281	1 327 866	1 380 281	1 327 866	1 307 866	1 307 866	1 167 551	1 327 866	1 307 866	1 307 866	1 167 551
Treated	1 075 276	1 075 276	1 075 276	1 043 132	1 075 276	1 043 132	1 027 405	1 027 405	917 123	1 043 132	1 027 405	1 027 405	917 123
Tips	313 199	313 199	313 199	295 668	313 199	295 668	291 135	291 135	260 033	295 668	291 135	291 135	260 033
Intrinsic Motivation	235 372	235 372	235 372	231 838	235 372	231 838	228 258	228 258	203 723	231 838	228 258	228 258	203 723
Image Motivation	265 693	265 693	265 693	258 300	265 693	258 300	254 714	254 714	227 136	258 300	254 714	254 714	227 136
SR Opt Out	261 012	261 012	261 012	257 326	261 012	257 326	253 298	253 298	226 231	257 326	253 298	253 298	226 231
Control	305 005	305 005	305 005	284 734	305 005	284 734	280 461	280 461	250 428	284 734	280 461	280 461	250 428
Clusters	653	653	653	653	653	653	653	653	653	653	653	653	653
Fpvalue	0.1	0.098	0.099	0.099	0.11	0.101	0.093	0	0.107	0	0	0	0
R-squared	0.412	0.435	0.436	0.517	0.436	0.517	0.519	0.604	0.534	0.518	0.52	0.606	0.536

Table E.6: DiD with FE (no trend)

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)
Post	-1.720***	-1.738***	-1.738***	-1.658***	-1.894***	-1.773***	-2.428***	-2.377***	-2.561***	-2.509***
	0.133	0.132	0.132	0.141	0.122	0.146	0.134	0.132	0.129	0.143
Tips x Post	-0.129*	-0.127*	-0.127*	-0.124*	-0.123*	-0.099	-0.203**	-0.215***	-0.203***	-0.196**
	0.072	0.072	0.072	0.073	0.064	0.073	0.081	0.082	0.073	0.084
Intrinsic x Post	-0.098	-0.101	-0.101	-0.079	-0.079	-0.063	-0.292***	-0.292***	-0.282***	-0.278***
	0.067	0.067	0.067	0.069	0.062	0.07	0.087	0.089	0.081	0.088
Image Motivation x Post	-0.246***	-0.247***	-0.247***	-0.257***	-0.278***	-0.240***	-0.502***	-0.518***	-0.522***	-0.510***
	0.085	0.084	0.084	0.088	0.079	0.089	0.096	0.097	0.089	0.099
SR Opt Out x Post	-0.116	-0.115	-0.115	-0.109	-0.108	-0.077	-0.242***	-0.250***	-0.234***	-0.234***
	0.075	0.075	0.075	0.077	0.068	0.078	0.085	0.085	0.077	0.086
Indigent status		2.369***	2.369***	2.398***	2.415***	2.022***	1.443***	1.446***	1.447***	0.994***
		0.319	0.319	0.33	0.338	0.327	0.39	0.388	0.388	0.365
Frequency (-1)				-0.027				-0.014		
				0.038				0.038		
Billed amount (-1)					0.005***				0.005***	
					0				0	
Tariff rate (-1)						-0.053***				-0.053***
						0.004				0.004
Post x indigent							2.173***	2.157***	2.107***	2.289***
							0.234	0.238	0.223	0.266
Tips x indigent							-0.054	-0.004	0.064	-0.118
							0.255	0.25	0.239	0.273
Intrinsic x indigent							-0.445	-0.46	-0.368	-0.341
							0.321	0.324	0.304	0.354
Image Motivation x indigent							-0.438	-0.426	-0.331	-0.509
							0.307	0.307	0.287	0.331
SR Opt out x indigent							-0.115	-0.134	-0.099	-0.036
							0.3	0.286	0.278	0.322

Tips x indigent x Post							0.258	0.283*	0.248*	0.300*
							0.158	0.161	0.14	0.157
Intrinsic x indigent x Post							0.162	0.192	0.174	0.166
							0.141	0.145	0.131	0.149
Image Motivation x indigent x Post							0.527***	0.541***	0.495***	0.556***
							0.166	0.172	0.156	0.171
SR Opt Out x indigent x Post							0.181	0.178	0.143	0.203
							0.174	0.176	0.156	0.178
Constant	26.335***	25.485***	25.485***	25.615***	24.512***	26.600***	25.962***	25.991***	24.876***	27.010***
	0.255	0.293	0.293	0.291	0.329	0.271	0.297	0.292	0.327	0.274
TB baseline	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1 380 281	1 380 281	1 380 281	1 307 866	1 307 866	1 167 551	1 327 866	1 307 866	1 307 866	1 167 551
Treated	1 075 276	1 075 276	1 075 276	1 027 405	1 027 405	917 123	1 043 132	1 027 405	1 027 405	917 123
Tips	313 199	313 199	313 199	291 135	291 135	260 033	295 668	291 135	291 135	260 033
Intrinsic Motivation	235 372	235 372	235 372	228 258	228 258	203 723	231 838	228 258	228 258	203 723
Image Motivation	265 693	265 693	265 693	254 714	254 714	227 136	258 300	254 714	254 714	227 136
SR Opt Out	261 012	261 012	261 012	253 298	253 298	226 231	257 326	253 298	253 298	226 231
Control	305 005	305 005	305 005	280 461	280 461	250 428	284 734	280 461	280 461	250 428
Clusters	653	653	653	653	653	653	653	653	653	653
Fpvalue	0.07	0.067	0.067	0.065	0.012	0.105	0	0	0	0
R-squared	0.071	0.072	0.072	0.074	0.094	0.086	0.077	0.079	0.098	0.091

Table E.7: Robustness checks: DiD with trend, no fixed effects. Creating an alternative control group which is follows the late receivers.

	I Monthly consumption (kl)	II Monthly consumption (kl)	III Monthly consumption (kl)	IV Monthly consumption (kl)	V Monthly consumption (kl)	VI Monthly consumption (kl)	VII Monthly consumption (kl)	VIII Monthly consumption (kl)	IX Monthly consumption (kl)	X Monthly consumption (kl)	XI Monthly consumption (kl)
Tips x Post	-0.132*	-0.132*	-0.125*	-0.122*	-0.124*	-0.122*	-0.098	-0.195**	-0.203**	-0.192***	-0.184**
	0.073	0.073	0.072	0.072	0.073	0.065	0.072	0.08	0.081	0.072	0.083
Intrinsic x Post	-0.118*	-0.118*	-0.094	-0.097	-0.085	-0.086	-0.06	-0.312***	-0.311***	-0.300***	-0.288***
	0.068	0.068	0.067	0.067	0.07	0.062	0.07	0.086	0.088	0.08	0.087
Image Motivation x Post	-0.247***	-0.247***	-0.242***	-0.243***	-0.251***	-0.273***	-0.228***	-0.502***	-0.516***	-0.520***	-0.504***
	0.085	0.085	0.085	0.084	0.086	0.078	0.087	0.096	0.097	0.09	0.1
SR Opt Out x Post	-0.134*	-0.134*	-0.112	-0.111	-0.12	-0.119*	-0.078	-0.276***	-0.284***	-0.267***	-0.256***
	0.076	0.076	0.075	0.075	0.075	0.066	0.077	0.082	0.082	0.074	0.083
Trend	-0.191***	-0.191***	-0.192***	-0.194***	-0.189***	-0.212***	-0.200***	-0.270***	-0.269***	-0.284***	-0.280***
	0.028	0.028	0.015	0.015	0.015	0.013	0.016	0.015	0.015	0.014	0.016
Indigent status				2.370***	2.389***	2.411***	2.019***	1.434***	1.444***	1.447***	0.967***
				0.318	0.325	0.332	0.325	0.382	0.382	0.381	0.362
Frequency (-1)					-0.017				0		
					0.037				0.037		
Billed amount (-1)						0.005***				0.005***	
						0				0	
Tariff rate (-1)							-0.053***				-0.054***
							0.004				0.004
Post x indigent								2.089***	2.071***	2.027***	2.199***
								0.235	0.238	0.223	0.269
Tips x indigent								0.14	0.138	0.199	0.072
								0.251	0.24	0.231	0.271
Intrinsic x indigent								-0.486	-0.510*	-0.411	-0.348
								0.295	0.299	0.279	0.324
Image Motivation x indigent								-0.45	-0.45	-0.345	-0.503
								0.298	0.297	0.275	0.32
SR Opt out x indigent								-0.087	-0.133	-0.099	0.023
								0.296	0.283	0.275	0.313

Tips x indigent x Post								0.225	0.248	0.218	0.267*
								0.158	0.162	0.141	0.156
Intrinsic x indigent x Post								0.233	0.265*	0.241*	0.245
								0.143	0.146	0.131	0.151
Image Motivation x indigent x Post								0.553***	0.569***	0.524***	0.592***
								0.159	0.165	0.149	0.164
SR Opt Out x indigent x Post								0.272	0.277	0.237	0.296*
								0.176	0.176	0.156	0.179
Constant	23.727***	23.727***	27.102***	26.260***	26.280***	25.284***	27.312***	26.931***	26.972***	25.933***	28.036***
	0.195	0.195	0.291	0.323	0.309	0.362	0.305	0.326	0.309	0.36	0.307
Observations	1 379 393	1 379 393	1 379 393	1 379 393	1 357 734	1 357 734	1 210 934	1 379 393	1 357 734	1 357 734	1 210 934
Treated	1 075 276	1 075 276	1 075 276	1 075 276	1 058 615	1 058 615	944 484	1 075 276	1 058 615	1 058 615	944 484
Treat1	313 199	313 199	313 199	313 199	308 128	308 128	274 927	313 199	308 128	308 128	274 927
Treat2	235 372	235 372	235 372	235 372	231 713	231 713	206 759	235 372	231 713	231 713	206 759
Treat3	265 693	265 693	265 693	265 693	261 901	261 901	233 417	265 693	261 901	261 901	233 417
Treat4	261 012	261 012	261 012	261 012	256 873	256 873	229 381	261 012	256 873	256 873	229 381
Control	304 117	304 117	304 117	304 117	299 119	299 119	266 450	304 117	299 119	299 119	266 450
Clusters	653	653	653	653	653	653	653	653	653	653	653
Fpvalue	0.068	0.068	0.078	0.076	0.064	0.012	0.121	0	0	0	0
R-squared	0.012	0.012	0.071	0.072	0.073	0.093	0.085	0.076	0.077	0.097	0.09