Getting on the Grid: The Politics of Public Service Formalization in Urban India

Pre-analysis plan

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December 8, 2018

Abstract

Citizens in many cities of the developing world struggle to access state services. Instead, they rely on services that are provided informally or illegally. Such 'off the grid' services tend to be intermittent, expensive, and of low quality. Their existence undercuts the fiscal contract between citizens and states, and undermines governments' ability to invest in infrastructure. This phenomenon raises three questions. First, what prevents poorer citizens from accessing public services to which they are legally entitled? Second, does transitioning into formal, state service provision affect political attitudes and behaviors? And third, does formalization improve welfare outcomes for marginalized groups? We develop a theoretical framework clarifying (a) the causes of low service delivery; (b) the impact of formalization on political attitudes and behaviors; and (c) its consequences for welfare outcomes. To test the theory, we conduct a cluster randomized control trial in Mumbai, India. A 2014 court ruling afforded all of the city's slum residents the right to obtain municipal water connections. Yet even though Mumbai boasts a well-functioning chlorinated supply system, uptake of connects in the slums has been slow. Partnering with local NGOs, we assess how two types of interventions—bureaucratic assistance, and political pressure in the form of group voice—shape communities' likelihood of of securing municipal water connections, and thus formalized water supply. We then leverage these encouragements to estimate downstream impacts. This draft document pre-registers our hypotheses and offers a fully coded analysis using a simulated dataset. It was filed after the baseline and randomization had been completed but before the implementation of the intervention began.

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1 Introduction

A core responsibility of urban governments worldwide is to provide citizens with access to basic services such as electricity, drinking water, street lights, and sanitation. Yet, even in contexts where governments supply these utilities, many citizens remain "off the grid," relying instead on informal or illegal providers. Existing work suggests that this mode of accessing services is suboptimal. For citizens, non-state amenities are generally more expensive than publicly provided alternatives, intermittent, and of low quality. Widespread dependence on the informal service sector entails a loss of revenue for governments—in the form of forgone user fees and taxes—placing a brake on future infrastructural investments. More deeply, the absence of a fiscal link between governments and certain groups of citizens—notably, marginalized ones—might generate cycles of political disengagement: citizens who receive little from the state may see few reasons to participate electorally or to articulate their interests to state authorities; in turn, state officials will have correspondingly little incentive to increase service provision to these population groups.

Three sets of questions animate this project: What causes citizens to formalize their access to basic services in developing countries? What are the effects of formalization on attitudes toward the state, as well as political participation? Does formalization improve the welfare of poor citizens?

To address the first of these questions, we develop a theory to explain what prevents citizens from formalizing. In the framework we describe, formalization is a two-step process: citizens submit an application to get connected, and bureaucrats then decide whether to accept the application—in which case connections are given—or to reject it. Where bureaucracies are Weberian, bureaucrats grant connections when an applicant successfully demonstrates she meets a set of objective, pre-specified eligibility criteria. The formalization challenge thus hinges on empowering low-skilled, time-strapped citizens to navigate the bureaucratic process needed to prove eligibility. Alternatively, if bureaucrats have incentives to shirk, or if they benefit personally or professionally from the status quo, these citizen-side efforts will be insufficient to produce formalization. We focus on situations where bureaucrats are *politically* captured—a common characteristic of weakly institutionalized settings. Here, the motivations of politicians charged with bureaucratic oversight are pivotal. Politicians who perceive that formalization will positively impact their re-election chances exert pressure on bureaucrats to process applications expeditiously and deliver services. If incumbent politicians fail to impose such pressure, applications are rejected. On this account, therefore, rates of formalization depend on expectations of political accountability. Citizens' must jointly and credibly signal to elected representatives their willingness to punish formalization failures and reward formalization successes. Only then will public services flow to deprived groups.

We next consider the consequences of formalization for citizens' attitudes and behaviors regarding the state and electoral politics. Attaining formalized services via a routinized process of submitting applications may cause citizens to update their beliefs about the competence and capacity of the state and its functionaries. This may, concomitantly, increase citizens' willingness to pay fees and taxes in exchange for those services, strengthening the fiscal contract between states and citizens. Meanwhile, we expect that attaining formalization through a *political* channel—that is by pressuring elected officials to intervene on citizens' behalf—will increase beliefs that electoral accountability mechanisms are effective, and thus boost participation in electoral politics. To be sure, these conjectures rest on the assumption that the services provided by the state are better than those obtained informally or illegally (the status quo situation). Provided this condition is met however, formalization should positively shape citizens' impressions about the state and politics.

Finally, we look at the upshots of formalization for the welfare of women and children. In poorer countries, women often bear primary responsibility for getting basic supplies and attending to household needs—often a tiring, time-consuming struggle. Formalized provisioning may thus help foster women's empowerment, if it frees up time and energy that can be profitably spent on activities beyond household chores. Better and more plentiful basic services are also widely thought to lie behind improvements in the health outcomes of infants and children.

To test these various claims, we conduct a cluster randomized control trial looking at municipal water access in Mumbai, India. Mumbai is one of the world's megacities, and home to a vast urban slum population. Inadequate water supply ranks among the most pressing challenges facing poor citizens there. A 2014 court ruling afforded all Mumbai slums the right to obtain connections to the city's well-functioning chlorinated water supply system—a right they had previously been denied. Yet subsequent uptake of formalized, fee-based water services has been slow. Many slum residents continue to rely on private, informal, or illegal water-service provisioning. Dependence on non-state utilities is costly for citizens insofar as informal providers are known to extract high rents in exchange for low-quality water services. Moreover, pervasive incidence of "non-revenue water" has limited the government's ability to make infrastructural investments and achieve economies of scale in supply and delivery.

We craft two interventions based on our theory about the constraints to formalization faced by citizens. Partnering with a local NGO, we begin by evaluating how these interventions influence individuals' likelihood of formalizing access to municipal water connections. In the first treatment arm, our NGO partners provide assistance to citizens in overcoming the bureaucratic hurdles involved in demonstrating eligibility for formal services. Workers help citizens complete the onerous paperwork, and assist in obtaining proof-of-residency certificates as well as documents concerning the legal status of the slum colony. The second treatment arm involves encouraging citizens to overcome the "political co-ordination constraints." Our implementing partner encourages citizens to organize political pressure drives: a series of town hall meetings centered on the topic of water access, petitions, and group visits to the office of the local municipal councilor. The goal is to signal to local politicians and parties that citizens are united and mobilized around formalization, and are thus likely to punish incumbents electorally in the event that water connections are denied to them.

For the experiment, we randomly assign slums and household clusters within slums to one of four conditions, including a pure control, in a factorial design. We interview approximately 50 subjects at baseline, midline, and endline within each experimental site. One bundle of outcome measures relates to formalization. A second bundle captures political participation, attitudes and behaviors about the state and taxes, and human welfare. A third bundle explores human welfare consequences for women and children. For these latter outcomes, we leverage the encouragement treatments to estimate the effects of formalization itself, under the assumption of there being no exclusion restriction violations.

This study aims to make several contributions. First, it adds to our understanding of the factors that shape public service provision in the developing world (Lake and Baum 2001; Bueno de Mesquita et al. 2003; Bates 2005; Stasavage 2005; Nooruddin and Chhibber 2008; Min 2015; Bhavnani and Lee 2018). Whereas prior studies have tended to focus on state-side factors explaining variations in public service delivery, we assess the interaction between citizen-side constraints and the incentives of state actors in generating formalization outcomes.

Further, we contribute to a burgeoning body of literature on the fiscal contract between states and citizens (Timmons 2005; Bratton 2012; Bodea and LeBas 2016; Weigel 2017). It is well known that reliance on "unearned" revenues such as oil rents tends to limit state responsiveness, which may weaken citizens' loyalty to the state. A salient question is whether bringing marginalized groups into the orbit of the state—perhaps for the first time—can give rise to pro-state attitudes and behaviors. Effective formalization could fortify state institutions by (a) persuading citizens that government can provide things of value, and (b) spurring tax compliance. To date, evidence on this proposition is lacking.

Last, we advance scholarship on the drivers of political participation (Uhlaner 1989; Brady, Verba, and Schlozman 1995; Krishna 2002; Chen 2013; Fair et al. 2017). Low political engagement by marginalized groups—for example, rural-to-urban migrants who disproportionately populate the slums we stud—may distort policy outcomes in favor of the rich and privileged. Greater voice by these groups might thus lead to a rise in political equality. Work on distributive politics demonstrates that the receipt of gifts and handouts can cause pro-incumbent voting as well as higher electoral turnout. What is less clear is whether the *process* by which citizens obtain services—for example, through a bureaucratic or a political channel—moderates participation outcomes. This is a question on which we are able to provide experimental leverage.

2 Background

Greater Mumbai is home to 20 million people—a population larger than Australia's. Studies demonstrate that Mumbai's slum colonies suffer from government neglect and intermittent utility supply. Water connectivity is an especially pressing problem. It is estimated that only 5 percent of households in non-notified slums have access to safe piped water. This lack of potable water poses a serious threat to public health. Moreover, women and girls disproportionately shoulder the burden of procuring household water supplies. Mumbai is not alone in these regards. It is representative of a broader class of cities in the developing world—from Sao Paulo to Mexico City to Cape Town—where water shortages impair the wellbeing of subaltern groups.

Mumbai has long maintained a chlorinated central water supply system. Yet progress toward water equity in the city was stalled for decades by a policy that effectively tied eligibility for municipal water access to slum rehabilitation schemes. In particular, non-notified slums were precluded from applying for official connections. This meant that citizens living in non-notified slums were left to rely on informal providers—paying prices as much as 250 times higher than the municipal rate. Moreover, these providers—some of whom form part of a "water mafia"—often procure their water supply by illegally siphoning it off from the municipal water mains, creating leakages and hindering services for those connected to the grid.

In 2014, a Bombay High Court ruling issued a landmark judgment declaring that "the state cannot deny the water supply to a citizen on the ground that he is residing in a structure which has been illegally erected." The Mumbai municipal government has publicly committed to increasing the number of water connections in response. The task of broadening access is an enormous one. 12 million Mumbai residents live in informal settlements, half of which are estimated to be non-notified. The city is presently at a turning point, therefore: the legal framework governing access to water is now conducive to equalizing connectivity. But for this to happen, a "big push" is needed across a number of domains.

It is worth noting that a swath of Mumbai's population is composed of recently settled migrants, many of whom end up residing in unplanned *bastis*. The role played by local political actors is highly relevant in our context. Nativist political parties, such as the Shiv Sena and the Maharashtra Navnirman Sena, have long campaigned against providing municipal services to internal migrants. Notwithstanding the Bombay High Court's ruling, therefore, poor city residents in Mumbai face both bureaucratic and political obstacles to securing municipal services.

3 Theory

This section outlines two sets of theories. The first gives an account of the formalization process in developing democracies. It elucidates the factors that prevent citizens from formalizing, and interventions that should mitigate these constraints. The second explains how formalization might restructure citizens' expectations and payoffs, affecting their attitudes and behaviors with respect to democratic politics and state institutions.

3.1 Causes of formalization

How do citizens attain formalization and what actions can citizens take to bolster their chances of accessing public services to which they are entitled? Bureaucrats are the key providers of formal service access in the setting we study: they process applications, assess needs, devise plans, and commission public works. We posit that formalization likelihood depends on the incentive structures bureaucrats face—chiefly, those pertaining to their careers.

Two main factors shape bureaucrats' retention and promotion prospects. First, advancement may be decided on meritocratic grounds. Movement up the career ladder requires that bureaucrats perform their job duties in accordance with well-defined rules and procedures (Alesina and Tabellini 2007; Enikolopov 2014). This view of bureaucracy conforms with the Weberian "rational" ideal. A second pathway to advancement involves satisfying the demands of elected politicians who exert discretionary sway over bureaucrats' career trajectories. Standard delegation models stipulate an important role for incumbent politicians in monitoring bureaucratic performance, selecting compliant types, and sanctioning bureaucratic agents who deviate from policy implementation guidelines. Yet a challenge frequently arises: these powers may leave room for a politician to impel bureaucrats to promote the politician's own *private* interests, whether they be personal or electoral (Iyer and Mani 2012). Thus for bureaucrats, an alternative means to get ahead is to curry favor with political patrons.

Each view carries different implications for how citizens might attain formalization. We spell out two scenarios that are not mutually exclusive.

Case 1: We begin with the assumption that supplying public services to citizens is costly for the state. From the perspective of individual bureaucrats, the expansion of formal public services takes time, effort, and perhaps limits rent-seeking opportunities. Accordingly, the state may put in place onerous procedures to stop a flood of citizens gaining access through official channels. Citizens wanting government-provided services are often unable to overcome these high barriers to entry. Such logistical and administrative impediments can be termed *bureaucratic navigation constraints*. For example, citizens who have never interacted with the bureaucracy before may lack information about eligibility requirements and thus hesitate to submit formalization requests. Citizens without education or language skills may struggle to fill out paperwork and negotiate complex bureaucratic apparatuses. Crucially, though, when paperwork is properly submitted and the state is Weberian, bureaucrats process applications in an objective manner, and grant formalization to citizens deemed eligible. Bureaucrats who decline to do so—perhaps because of shirking—would be violating official rules and procedures, making them liable to career setbacks.

If this account is correct, facilitation interventions—in the form of practical assistance given to citizens trying to overcome these various bureaucratic obstacles—should increase formalization rates. It also stands to reason that such interventions would register more of an impact among marginalized citizens who possess lower levels of human capital—in terms of education, income, and social-group status. (With that said, however, we cannot rule out the countervailing possibility that such citizens traits may provoke greater discrimination on the part of state agents. This is something we consider in the hypotheses, below.)

Case 2: Conceivably, it is not enough for citizens wanting formalization to jump through bureaucratic hoops. Bureaucrats may not be driven to provide formalization unless they are pressured to do so by elected politicians who maintain de facto control over their careers. What, then, determines whether politicians will act to push through formalization requests?

Voter coordination, we suggest, holds the key. Politicians are office-motivated and seek the support of citizens during elections. Given scarce time and resources, politicians attend to issues that are likely to increase their re-election chances. They take actions expected to garner the most votes for a given set of inputs. This means investing in popular, low-cost programs that reach a large segment of voters, and avoiding expensive investments that benefit the few.

The problem is that politicians receive a plethora of signals about which issues are important to voters. Voters themselves have diverse needs to which they assign different priorities. This gives rise to a coordination dilemma. If voters cannot credibly convey a promise (or threat) of electoral reward or punishment over any *particular* demand, politicians will have neither the information nor the incentive to target issues for which action would benefit both themselves and constituents.

For citizens, then, *political coordination constraints* need to be overcome: factors that impede citizens' ability to mobilize collectively to convey their demands—in this instance, over formalization—to elected representatives. Only when this is achieved will politicians use their influence to pressure bureaucrats to provide services. Coordination, we presume, will be easier in places where there is more social capital. Yet even supposing politicians get the message, the impact of voter coordination may be conditional. Rational politicians should be more reactive to collective demands for formalization in areas that have a greater share of registered voters; that have at least partially supported his/her political party in the recent past; and that share his/her ethnicity. In these circumstances, the likely electoral returns to furnishing connections should be greatest. Additionally, incumbents aligned with a ruling party may be better positioned to shape bureaucratic action than opposition-aligned politicians. Nativist politicians may also be disinclined to allow formalization for migrants whose entrenchment could pose an economic or cultural threat to their core base of native supporters.

To sum up, these frameworks suggest the possibility of a status quo in which citizens facing bureaucratic and political constraints do not seek public services, bureaucrats do not expand delivery of these utilities, and political candidates face few incentives to intervene on citizens' behalf. Consequently, formalization does not occur. Below, we describe two interventions crafted to overcome each type of citizen constraint. By evaluating their effectiveness, we hope to parse the degree to which these theoretical accounts explains reality.[1]

3.2 Effects of formalization on political attitudes and behaviors

We next examine the impact of formalization on citizens' attitudes and behaviors with respect to the state and politics. This will be the topic of the second paper based on our study. Here, we lay out expectations about how formalization shapes interactions with the state, political participation, and tax compliance. We focus on one set of actors—citizens—and their response to formalization. Note that we take formalization to mean "successful formalization" for the time being: a process that ends in citizens receiving a high quality, low cost service. We return to consider how expectations might shift if this condition is relaxed.

3.2.1 Effect of formalization on political behavior: mechanisms

At baseline, we assume that citizens who lack formal access to services perceive the state as corrupt, captured by special interests, and mostly unresponsive to citizens' needs. This depiction is borne out by a large body of empirical evidence from developing countries, where rent seeking is widespread, and popular trust in state institutions is low (Catterberg and Moreno 2006).[2] Formalization, in our argument, can effect a positive shift in these beliefs and attitudes due to five potential reasons.

First, by giving citizens access to improved services, formalization can provide citizens with a *credible signal about the state's probity and effectiveness.* In particular, if citizens begin receiving lower cost, higher quality services from the state as compared to the services they previously acquired through non-state sources, they will be more likely to attribute these improved services to the efficacy of the government and, in turn, begin viewing the government in a positive light.

Second, as citizens register an increase in their welfare, they may increase their levels of *satisfaction* with the government and feel gratitude towards both bureaucrats as well as elected officials. The receipt of services could stand as concrete evidence that state agencies fill valued functions; and citizens could positively update their assessments accordingly (cf. Coate and Morris 1995). The literature on distributive politics has shown that the receipt of benefits—whether in the context of campaign handouts, transfers, or welfare programs—may increase pro-incumbent voting, suggesting a "gift-exchange" model of voting behavior (Manacorda, Miguel, and Vigorito 2011; Bechtel and Hainmueller 2011).

Third, formalization may also change voters' sense of *political efficacy.* On the one hand, it may add to voters' stock of internal efficacy—that is, their beliefs about their own ability to effectively participate in politics and sway decision-making—particularly in cases where they engaged in concerted political action that achieved the desired results. On the other hand, the first-hand experience of formalization via political intermediaries might also contribute to external efficacy: the idea that the government is responsive to citizens' concerns (Niemi, Craig, and Mattei 1991). Many of the impediments that prevent citizens from approaching state officials—for instance, worries about having to pay bribes, or fear of discrimination against low-income or subaltern groups—should be lessened following a successful formalization experience. Indeed, positive "first

[1] A caveat to keep in mind is that out interventions may spark a response by vested interests. In the hypotheses enumerated below, we consider the possibility that citizens seeking formalization encounter a negative response from, for example, private water providers. We also consider the role of brokers. On the one hand, citizens who rely on brokers at baseline may find it easier to formalize—if, say, brokers further smooth the application process. On the other hand, the presence of strong brokers could make formalization harder, if those brokers anticipate a loss of future business and work to subvert formalization attempts.

[2] It is worth emphasizing the possibility that citizens with low prior exposure to the state might also attach a high degree of uncertainty to these beliefs.

impressions" have been demonstrated to have a disproportionate effect in spurring utilization of health and education services (Rabin and Schrag 1999). A similar mechanism might operate in our context as well.

Fourth, formalization may create *reciprocity* among beneficiaries of state services. The literature on tax morale highlights the weak, non-pecuniary motivations that often lead citizens to evade tax payments, for example. Citizens who think that the state offers poor "value for money" may see little reason to pay taxes which they expect to be squandered. This skepticism, if widely shared, could also retard the formation of social norms surrounding tax payment—a key input into "quasi-voluntary compliance" (Levi 1989). Formalization might remedy this pathology by creating gratitude on the part of citizens, who now see themselves as indebted to the state. This would lead them to engage in reciprocal behaviors such as tax compliance and direct and indirect types of political engagement.

Fifth, and finally, putting citizens "on the grid" can also increase citizens' visibility in the state's eyes, enhancing their fear that non-payment will be detected. In particular, citizens are predicted to become more cognizant of *monitoring* by agents of the state, and this in turn might lead them to become more observant of their duties and responsibilities as responsible and dutiful civic participants in the democratic process.

Sixth, formalization may stoke citizen *gratitude* toward the state through an economic channel. If citizens find themselves with more disposable income post-formalization—because state-provided services are cheaper than informal ones—they might credit the state with this economic windfall.

Each of the above mechanisms is contingent on formalization proceeding smoothly and citizens perceiving the end results of formalization to be advantageous. Thus, if it is true that formalization improves political participation through these mechanisms, we should expect that formalization improves objective outcomes for citizens and that it improves their satisfaction and sense of efficacy. Our analysis thus includes tests of these intermediate outcomes to further test our theory. Conversely, if the formalization process turns out to be a slow, frustrating process, or the resulting services fall short of expectations, then citizens' disappointment and anger in this scenario may could lead to disengagement and perhaps even backlash. To explore these possibilities, we also include measures in our survey instruments intended to pick up "thwarted expectations."[3]

3.2.2 Political attitudes, behaviors

As a result of the mechanisms described above, formalization could lead to an improvement in citizens' attitudes and behaviors towards the bureaucracy, electoral politics, or both. If citizens attribute formalization to the bureaucracy, then the receipt of formalized services could improve their attitudes toward, and perceptions of, the bureaucracy. Meanwhile, if citizens attribute formalization primarily to the efforts of elected officials, then their attitudes towards elected officials, and their perceptions of the democratic process as a whole, could improve.

As a result of improved attitudes and perceptions, engagement with state/bureaucratic institutions should also increase. Higher levels of trust in state officials should lead citizens to demand access to the larger menu of services that states offer. Therefore, we anticipate the achievement of formalization by marginalized citizens to generate behavioral changes across a number of domains pertaining to state action. For example, formalization could enhance citizens' likelihood to contact bureaucratic officials and demand additional services from the state.

At the same time, formalization could lead citizens to become more engaged with political processes - both electoral and non-electoral. It might increase political interest, rates of contacting politicians, and various forms of formal and informal political participation. The upshot will be higher engagement with politics, manifested in turnout propensity (because of higher expected benefits of voting relative to its costs), informal participation (e.g. attendance at community meetings), and political knowledge (due to the higher expected returns to learning how the political system works).

[3]Another way we attempt to empirically capture this phenomenon by comparing the impact of treatment in forest and footpath slums—places where, for administrative reasons, we expect the interventions may be less likely to succeed—with its impact in all other slums, where we judge the probability of success to be much higher.

In our main analyses, we investigate the impact of formalization on attitudes and behaviors toward both the state/bureaucracy and electoral politics, irrespective of the channel by which formalization was obtained. However, if citizens view elective politics and the state/bureaucracy as distinct entities and are able to disentangle who is primarily responsible for provisioning, then the *means* by which citizens attain formal access to state-provided services—whether through a bureaucratic channel or one mediated by elected politicians—may give rise to divergent effects across outcomes. How citizens secure formalization may be consequential if it informs voters about the true influence that bureaucrats and politicians have over state organs. In particular, those who gain access to state services via political mediation may be disposed to see electoral politics as the optimal way to "get things done." Conversely, those who get formalized service access through a predictable, bureaucratic procedure may solely attribute credit to the state apparatus, with no positive "spillover effects" for elected elites. In exploratory work, therefore, we will examine whether the pathways to formalization—whether bureaucratic or electoral—differentially impact citizens' attitudes and behaviors toward state bureaucratic organs and electoral processes.[4]

3.2.3 Tax compliance

Although formalization and taxation are distinct, formalization almost invariably requires the payment of extra fees to the state for services rendered—for example property tax in the case of land titling, or monthly payments for electricity and water. One way in which formalization might increase participation, therefore, is through these payment channels. We thus also consider the effect of legalized public service provision on tax morale and compliance. In particular, we predict that formalization will lead citizens to get "on the grid" and begin paying taxes and fees for the services they acquire from the government. In addition, formalization is likely to result in an improvement in citizens' tax morale, a change in their expectations of punishment for tax non-compliance, as well as positive spillovers in tax payments for other services that citizens routinely acquire from the government.

Note that several experimental studies—particularly those focused on nudge-type interventions—have sought to boost tax morale and compliance. The results are mixed (Thaler and Sunstein 1999; Hallsworth et al. 2017). As Luttmer and Singhal (2014, 158) note, however, "a few lines of text in a mailed letter may just not be sufficient to cause taxpayers to update their beliefs or attitudes in many contexts." Instead, longer, more meaningful exposure to state services—of the kind that formalization provides—may be needed to convince citizens of the government's competency.

Finally, recent work has documented the link between tax payment and political participation. In a phenomenon akin to an "endowment effect," tax-paying citizens become more politically engaged in order to have greater say over how their tax dollars are spent. In most models, taxpayers' core goal is to move public policy toward their preferred policy point (Weigel 2017). Martin (2014) argues that taxed citizens exist in the "domain of losses" and are thus especially eager to monitor governments and curb malfeasance. Thus improvements in tax compliance, political participation, and political attitudes—engendered by the processes of formalization that we study—might have a reinforcing effect.

3.3 Welfare effects of formalization for marginalized groups

Finally, we consider the impacts of formalization on the wellbeing of women and children. A range of evidence suggests that women are the primary household agents responsible for water gathering. The task of collecting water is typically more onerous when it is obtained illegally or informally, since these ways of accessing water rarely involve water being piped into the house. Instead it is collected in portable containers from trucks or common taps. There are three kinds of demands on those who gather water: traveling to the water source; waiting in line at the source; and the physical act of transporting the water back to home. In many contexts,

[4] In citizens' minds, elected officials may operate autonomously of state bureaucratic organs. In these contexts, getting state services may not automatically translate into heightened political participation. Rather, politics and state services may be delinked in citizens' minds.

gathering occurs often—perhaps several times a week—depending on the availability and portability of large containers.

The need to gather water means that those charged with it are significantly limited in their ability to engage in other activities. Water trucks follow schedules that individuals cannot control, and which may not be fixed. Waiting times might stretch from several minutes to a hour. Piped water access may thus increase the time available to women to engage in productive activities like education and employment outside the home. These, in turn, may empower them within the household too.

Meanwhile, child welfare is expected to improve via better health due to increased quantity and quality of drinking water. Regarding the latter, municipal water systems almost invariably treat the water pumped through public pipes with chlorine, eliminating most dangerous pathogens like e-coli, known to cause diarrhea and other health-related concerns. In the worst cases, contaminated water can cause infant mortality. In less extreme cases, water-related illness may force children to take time off school for recovery, leading them to receive less education. Such possibilities makes it important to investigate the welfare effects of formalization among children.

4 Description of treatments

Our interventions involve subsidizing two types of costs associated with formalization: bureaucratic navigation constraints, and political co-ordination constraints. Both interventions will be implemented by our partner NGOs, YUVA and Pani Haq Samiti.

4.1 T1: Bureaucratic facilitation

Navigating the process of obtaining a water connection through the Mumbai Municipal Corporation is a challenging enterprise for most citizens. It involves two phases: preparing and submitting the application form, and commissioning licensed plumbers and engineers to assess the site. Our NGO partners will provide assistance in both parts of the process.

The application form is long and convoluted; it demands significant input of time and skills. In particular, it must be completed online, even though many slum residents do not have easy access to a computer or know how to work one. T1 seeks to reduce these costs by having our NGO partners provide information and on-the-ground assistance in completing the paperwork. Specifically, over the course of approximately two months, trained NGO workers will make at least two visits each to households seeking connectivity. During these visits, assistants will help form groups of between five and ten neighboring households (who jointly submit the application), supply information and advice, including help with ancillary requirements such as proof-of-residency certification and documents concerning the legal status of the slum. The NGO workers will then help applicants from each slum plot submit their application forms to the municipal corporation using the online portal.

The application process also requires household collectives to hire a plumber at their own expense. The NGO workers will help slum residents liaise with the municipal engineers, and put households in contact with an appropriate plumber—one that meets the licensing demands of the ward engineers.

This treatment arm builds on insights provided by our NGO partners regarding what activities they have found most impactful in the past. It also reflects findings from other contexts. For example, as part of a study in Morocco, households were supplied with information about a credit scheme run by a local private water company (Devoto et al. 2012, 69). The facilitation drive had a large impact, increased the proportion of households getting a water connection by 59 percentage points. Thus the human capital costs associated with water connectivity appear to be important for obtaining connections.[5]

[5]Note that while we will evaluate T1 as a core part of this study, T1 will also be evaluated in comparative perspective with other projects that are being implemented in EGAP's Metaketa II Taxation initiative.

4.2 T2: Political co-ordination

Our alternative treatment arm will we seek to mitigate the second variety of costs tied to formalization: political co-ordination costs. The political constraints to securing public services—and specifically, water connections—in Mumbai have been extensively documented in the literature (Björkman 2015; Anand 2011). Case-study evidence from Mumbai, as well as the broader political-economy literature, suggests that overcoming bureaucratic obstacles may be necessary but insufficient for getting access to state benefits. This is because politicians play a key role in mediating access to the state. Politicians' support is generally required to galvanize bureaucrats into action and to ensure that projects get completed, yet elected representatives frequently evidence low levels of responsiveness to the concerns of citizens in non-notified slums—particularly those who are migrants. Indeed, politicians from nativist parties such as the Shiv Sena and MNS have historically tapped into the anti-migrant sentiment that exists among sections of the city's population by actively discriminating against migrants and preventing them from accessing formal services from the state. Thus, a key impediment facing slum dwellers seeking formalization is securing "buy-in" from local political elites.

In our setting, we hypothesize that the bureaucratic assistance provided by our first treatment arm will be more effective when combined with a second intervention to pressure local politicians to look favorably on the water applications of slum residents. In the second treatment arm, the NGOs will—in addition to the intervention to reduce bureaucratic-engagement costs—mount a series of campaigns to encourage households to act collectively to hold local politicians accountable over the issue of water connectivity.

The political intervention will see our NGO partners facilitating coordination between slum residents to apply political pressure on elected representatives. Specifically, they will organize delegations of residents from the slum clusters selected for this treatment to repeatedly go visit their respective Corporators/MLAs/MPs (i.e., the local municipal councilor and the state and national legislator) to demand water connections. They will also arrange the writing of letters and petitions sent to government authorities who have the authority to grant various ancillary permissions that are required in order for the BMC to establish water connections. Finally, the NGO workers will organize larger scale events (such as community town-hall meetings) to mount pressure on elected representatives to facilitate access to BMC water. The overarching goal is to signal clearly to politicians that voters are united in favor of achieving water access—with the implicit threat that they will vote against the incumbent at the next election and/or engage in further public protest if access is not granted.

5 Design

We implement a factorial, block-cluster randomized control trial in Mumbai, India. Randomization occurs at two levels: slums within blocks are assigned to either receive or not receive the political treatment (T2), then household clusters within slums are assigned to either receive or not receive the bureaucratic treatment (T1). Measures are taken using surveys administered at baseline and endline. This section details the sampling and randomization procedures.

5.1 Site selection

The site selection and sampling protocol was multi-staged, involving the selection of slums, household clusters within slums, and then individual households to be interviewed.

5.1.1 Slums

We first generated a list of slums in which to conduct the evaluation. Slums are densely population settlements that emerge and develop informally, without the state's permission. In some cases, slums go on to attain formal recognition and thus legal protection. In other cases, slums remain untitled and therefore vulnerable to clearance. Both titled and untitled slums appear in our sample.

A list of slums was drawn up in conjunction with our partner NGOs and our survey team. It is important to emphasize that no definitive list of Mumbai slums exists, and slum-level administrative data on municipal water connections are unavailable. Instead, the final slum list was prepared by compiling information on slum sites from an array of sources—including the 2011 census, NGO reports, and government lists—in addition to snowball sampling techniques implemented over the course of several months of detailed ethnographic fieldwork. Thus we ended up with a non-probability convenience sample, albeit one we believe is representative.

To enter into the final sample, a slum had to meet the following criteria:

1. A majority of slum households should not have a functioning BMC water connection.
2. The boundaries of the slum must be within reasonable proximity (1km) of a main municipal water pipe.
3. Our NGO partners should not have previously carried out significant work in the slum, or a large part thereof.
4. The slum must have been in continuous existence for at least three years, so as to minimize the chance of its removal over the course of the project.

Applying these criteria, we obtained a list of 76 slums.

5.1.2 Slum clusters

The chosen slums vary greatly in size. Some slums contain as few as 50 dwellings; others contain 10,000 dwellings or more. Because our treatments are high intensity—requiring door-to-door visits—it is not feasible to administer them to all households in the largest slums. For tractability, we specify our primary analytical unit to be the *slum cluster*. Slum clusters are plots of 50-200 households that are geographically contiguous and compact, and fall within the boundaries of a larger slum area. The target experimental population was 140 slum clusters, though we ended up being able to identify 152 such clusters.

Prior to baseline, our survey team conducted a mapping survey. Its goals were threefold: (a) to gather information on slum-level attributes, which were used to characterize our sample and gauge representativeness; (b) to divide slums into household clusters (henceforth referred to as clusters); and (c) to determine which clusters were eligible for inclusion in the final sample. The criteria for a cluster's inclusion were analogous to those for the slum as a whole—clusters with fewest water connections were preferred, as were those closest to the water main—along with two further considerations:

1. In places where a slum comprised fewer than ca. 200 households, the slum in its entirety was considered one cluster.
2. For very large slums, we selected multiple clusters for entry into the sample. This was done to boost the total number of clusters and thereby increase statistical power. The inclusion of more than one cluster per slum raises the potential issue of treatment spillovers. If, say, residents in a control cluster in a given slum learn that other residents elsewhere in the slum (assigned to treatment) are receiving assistance in getting water connections, they might increase their own efforts to secure connections. Such interference is likely to downwardly bias our estimates of average treatment effects. To minimize this possibility, we only took multiple clusters from the geographically largest slums. We also ensured that the distance between clusters was as great as possible (subject to clusters meeting other eligibility criteria).

5.2 Sampling and subjects

Measures are taken using surveys conducted at the household level. For the baseline survey, we sought to interview 50 respondents in each of the 152 clusters. For the midline and endline surveys, we will attempt to re-contact all respondents interviewed at baseline to make a three-wave panel survey. Given the relatively short duration of the project—about one year—we do not anticipate significant attrition across the three waves. Nevertheless, we specify our approach to managing possible attrition in the "contingencies" section below.

We used a random walk method to select respondents within clusters. Every 2nd, 5th, or 10th household was selected to be interviewed, depending on the number of households in the cluster. The opening section of the baseline survey comprised a set of screening questions. We excluded from the sample households that already possessed a BMC water connection, had applied for a BMC water connection within the previous year, or had been living in rented accommodation for less than two years. The birthday method was used to select individual adults to be interviewed.

6 Assignment

We have two units of randomization: *slums* and *clusters*. Randomization for T2 occurs at the slum level, while randomization for T1 occurs at the cluster level.[6]

6.1 Blocking

We pre-processed the data by dividing the 76 sampled slums into matched quadruples or pairs. This first involved dividing slums into four groups:

- *Group 1:* Slums containing a single cluster
- *Group 2:* Slums containing more than one cluster and less than 7 clusters
- *Group 3:* Slums containing more than six clusters and less than 10 clusters
- *Group 4:* Slums containing more than 9 clusters and less than 16 clusters

Groups 3 and 4 each contained only two slums and are each deemed to form a single block. Meanwhile, for slums belonging to Group 1, we created blocks that are quadruples of slums, and for slums belongning to Group 2 we created blocks that are pairs of slums. This blocking was based on the following slum-level variables, which we believe are likely to predict formalization:

- Altitude of the slum
- Whether or not the local BMC corporator was a member of the mayor's party (the Shiv Sena)
- Average housing quality
- Average time lived in the slum

```
# create slum list with count of clusters
  slums <- cluslist %>%
      count(slumid) %>%
      dplyr::rename(no_clusters = n) %>%
      arrange(no_clusters)

# recode the baseline outer walls variable as pacca
  mock_baseline %<>%
      mutate(blk_walls_pacca =
                 case_when(
                   b110 %in% c("a", "b", "c") ~ 1,
                   b110 %in% c("d", "e", "f", "g", "h", "i", "j") ~ 0))

slum_list <- mock_baseline %>%
    group_by(slumid) %>%
    summarise(blk_stay_av = mean(b47, na.rm = TRUE),
              blk_walls_pacca_av = mean(blk_walls_pacca, na.rm = TRUE),
```

[6] Note that this pre-analysis plan was filed after randomization had been performed. The description that follows implements the same randomization scheme as that used on the mock data.

```r
            number_of_clusters = length(unique(cluster_id))) %>%
  ungroup() %>%
  mutate(altitude = sample(0:20, 76, replace = TRUE),
         mayors_party = rbinom(76, 1, 0.2),
         corporator_religion
         = sample(c("Muslim_name", "Non_Muslim_name"), 76, replace = TRUE),
         corporator_marathi = sample(0:1, 76, replace = TRUE),
         corporator_party = sample(letters[1:8], 76, replace = TRUE),
         single_cluster = (number_of_clusters==1)*1,
         medium_clusters = (number_of_clusters %in% 2:6)*1,
         large_clusters_1 = (number_of_clusters %in% 7:9)*1,
         large_clusters_2 = (number_of_clusters %in% 11:15)*1) %>%
  arrange(number_of_clusters)
```

We generate pairs of most-similar slums, using a greedy matching algorithm:

```r
# block single-cluster slums as quadruples
  out1 <- block(slum_list, n.tr = 4, id.vars = "slumid", groups = "single_cluster",
              block.vars = c("number_of_clusters", "blk_stay_av",
                             "blk_walls_pacca_av", "altitude", "mayors_party"))


# block multi-cluster slums as pairs
  out2 <- block(slum_list, n.tr = 2, id.vars = "slumid", groups = "medium_clusters",
               block.vars = c("number_of_clusters", "blk_stay_av",
                              "blk_walls_pacca_av", "altitude", "mayors_party"))

# attach a variable to slum df w/ block ids
  slum_list %<>%
      mutate(
        block_id_single = createBlockIDs(out1, slum_list, id.var = "slumid"),
        block_id_multi =
          as.integer(createBlockIDs(out2, slum_list, id.var = "slumid") + 100),
        block_id = case_when(
        single_cluster==1 ~ block_id_single,
        medium_clusters==1 ~ block_id_multi,
        large_clusters_1==1 ~ as.integer(1001),
        large_clusters_2==1 ~ as.integer(1002))) %>%
      dplyr::select(-c(block_id_single, block_id_multi)) %>%
      arrange(block_id)
```

6.2 Randomization

First, half of the slums within each block is randomly assigned to receive T2 (the other half of the block does not receive T2):

```r
# randomize t2 within blocks
  slum_list %<>% mutate(t2 = block_ra(blocks = block_id))
```

We are now able to form the T1 blocks, which are:

- pairs of slums either receiving or not receiving T2 within quadruples, in the case of single-cluster slums
- individual slums in the case of multi-cluster slums

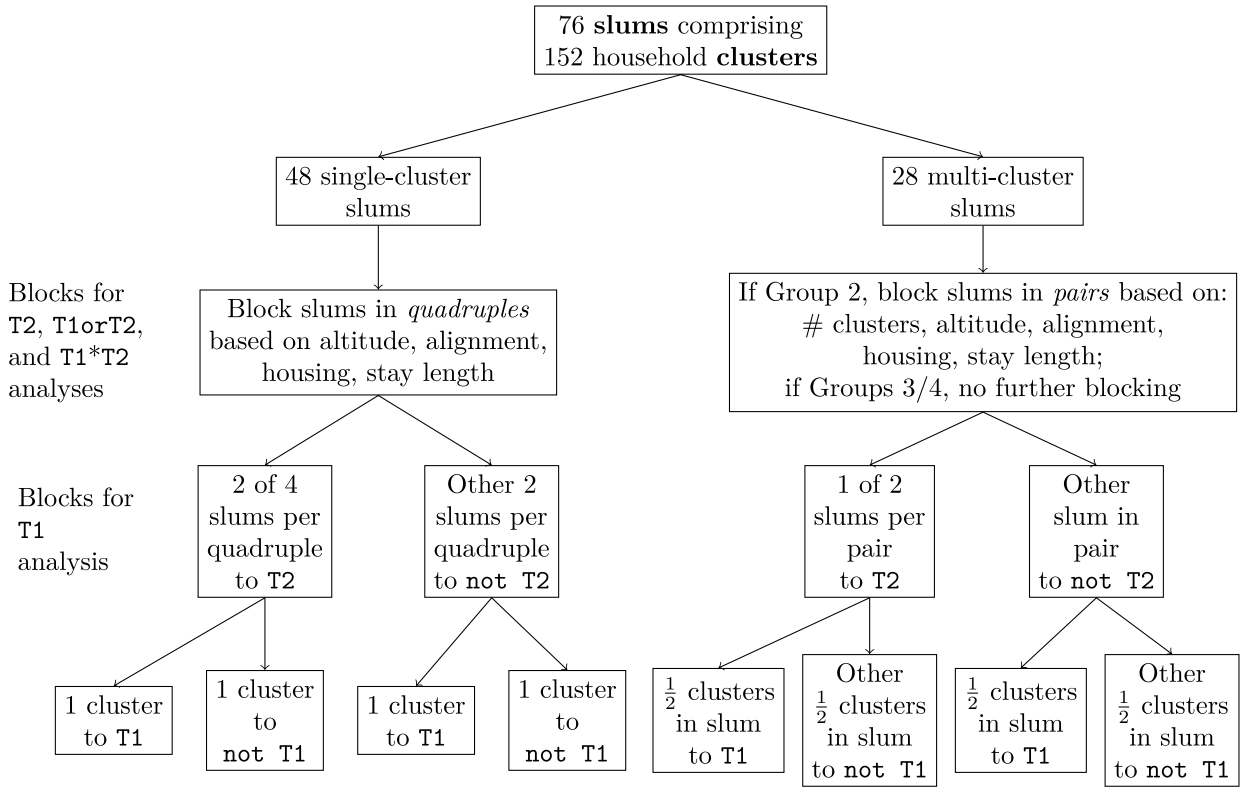

Figure 1: Randomization scheme

```
# begin with cluster list and merge in the t2 treatment assignments
  bl_cl_list <- mock_baseline %>%
    group_by(cluster_id, slumid) %>%
    summarise(n = n()) %>%
    ungroup() %>%
    left_join(slum_list, by = "slumid") %>%
    arrange(slumid)

# generate the blocks for t1 randomization
  bl_cl_list %<>%
    mutate(cl_block_id = as.numeric(factor(paste0(block_id, t2)))) %>%
    arrange(block_id, t2)

# randomize t1 within the cluster blocks
  bl_cl_list %<>%
    mutate(t1 = block_ra(blocks = cl_block_id))

# attach randomization scheme to the analysis data frame
  analysis_df %<>%
    left_join(bl_cl_list %>% dplyr::select(-c(slumid)), by = "cluster_id", all = TRUE)

# generate dummy variable for receiving t1 or t2
  analysis_df$t1ort2 <- (analysis_df$t1==1 | analysis_df$t2==1)*1
```

7 Estimation

We specify the core estimating equations. To estimate the average marginal effect of $T1$:

$$Y_{ij} = \alpha + \beta_1 T1_{ij} + \delta_c + u_{ij} \tag{1}$$

To estimate the average marginal effect of $T2$:

$$Y_{ik} = \alpha + \beta_1 T2_{ik} + \delta_s + u_{ik} \tag{2}$$

To estimate the interaction between $T1$ and $T2$:

$$Y_{ij} = \alpha + \beta_1 T1_{ij} + \beta_2 T2_{ij} + \beta_3 T1_{ij} T2_{ij} + \delta_s + u_{ij} \tag{3}$$

To estimate the effect of being assigned to *any* treatment:

$$Y_{ij} = \alpha + \beta_1 T1orT2_{ij} + \delta_s + u_{ij} \tag{4}$$

The estimate the effect of moderators of $T1$:

$$Y_{ij} = \alpha + \beta_1 T1_{ij} + \beta_2 M_{ij} + \beta_3 T1_{ij} M_{ij} + \delta_j + u_{ij} \tag{5}$$

The estimate the effect of moderators of $T2$:

$$Y_{ik} = \alpha + \beta_1 T2_{ik} + \beta_2 M_{ik} + \beta_3 T2_{ik} M_{ik} + \delta_k + u_{ik} \tag{6}$$

The estimate the effect of moderators of being assigned to any treatment:

$$Y_{ij} = \alpha + \beta_1 T1orT2_{ij} + \beta_2 M_{ij} + \beta_3 T1orT2_{ij} M_{ij} + \delta_k + u_{ij} \tag{7}$$

- i indexes individual respondents
- j indexes household clusters
- k indexes slums
- δ denotes block dummies (for either slums or clusters)
- Y denotes the dependent variable
- $T1$ is an indicator variable that takes one for subjects assigned to T1, and zero otherwise
- $T2$ is an indicator variable that takes one for subjects assigned to T2, and zero otherwise
- $T1orT2$ is an indicator variable that takes one for subjects assigned to T1 or T2, and zero otherwise
- M denotes a variable that is expected to moderate the effect of either or both treatments
- α is a constant term
- β are the coefficients of interest

In equations 2, 3, 4, 6 and 7, standard errors are clustered at the slum level—the level at which $T2$ is assigned. In equations 1 and 5, standard errors are clustered at the cluster level—the level at which $T1$ is assigned.

Because our hypotheses are directional, all tests, except those involving the analysis of heterogeneous effects, are one-tailed. The direction of the tests is given in the hypotheses section.

7.1 Covariates

In addition to the core estimation, just described, we also include a common set of individual-level covariates measured at baseline:

```r
## measures
# gender
  analysis_df$cov_b77_female <- (mock_baseline$b77 == "a")*1

# age [q91]
  analysis_df$cov_b91_age <- mock_baseline$b91

# education 1: illiterate
  analysis_df$cov_b97_literacy <- (mock_baseline$b97 == "a")*1

# income
  analysis_df$cov_b95_income <- mock_baseline$b95

# assets [count of number of assets owned]
  analysis_df$cov_b96_assets <- rowSums(mock_baseline[grep("b96_", names(mock_baseline))]
                                   == "Yes", na.rm = TRUE)

# title deed to house
  analysis_df$cov_b44_patta <- (mock_baseline$b44 == "a")*1

# renters
  analysis_df$cov_b4_renter <- (mock_baseline$b4=="b")*1

# electricity connection with bill
  analysis_df$cov_b25_electricity <- (mock_baseline$b25 == "a")*1

# voted in last bmc election [dummy = 1 if voted; 0 otherwise]
  analysis_df$cov_b113_voted <- (mock_baseline$b113 != "h")*1

# migrant [dummy = 1 if not permanent residence]
  analysis_df$cov_b99_migrant <- (mock_baseline$b99=="b")*1


# caste [dummy = 1 if SC or ST]
  analysis_df$cov_b107_varna <- ifelse((mock_baseline$b107 == "a"
                          | mock_baseline$b107 == "b"), 1, 0)

# religion
  analysis_df$cov_b105_hindu <- (mock_baseline$b105 == "a")*1

# pol visit [count of number of visits from three major politicians]
  analysis_df$cov_b117_polvisit <- rowSums(mock_baseline[grep("b117_",
                                   names(mock_baseline))] == "Yes", na.rm = TRUE)

# water scarcity [dummy = 1 for always or quite often; otherwise 0]
  analysis_df$cov_b10_waterscarce <- ifelse((mock_baseline$b10 == "a" |
                                   mock_baseline$b10 == "b"), 1, 0)

# ever paid water bill
```

```r
  analysis_df$cov_b7_waterbillever <- (mock_baseline$b7 == "a")*1

# time spent fetching
  analysis_df$cov_b11_fetchtime <- (rowSums(mock_baseline[grep("b11_",
                                        names(mock_baseline))], na.rm = TRUE)/4)

# land type [dummy for forest/footpath land]
  analysis_df$cov_b_fp_fr <- (mock_baseline$b_footpath_forest == "Yes")*1

# reliance on tanker water as primary source
  analysis_df$cov_tanker <- with(mock_baseline,
                                (pmax(b6_r1_c4,
                                b6_r2_c4,
                                b6_r3_c4,
                                b6_r4_c4,
                                b6_r5_c4,
                                b6_r6_c4,
                                b6_r7_c4)==b6_r4_c4)*1)

# input and code pre-treatment covariates common to all estimations here
cov <- c("cov_b77_female", "cov_b91_age", "cov_b97_literacy", "cov_b95_income",
         "cov_b96_assets", "cov_b44_patta", "cov_b4_renter", "cov_b25_electricity",
         "cov_b113_voted", "cov_b99_migrant", "cov_b105_hindu", "cov_b117_polvisit",
         "cov_b10_waterscarce", "cov_b7_waterbillever", "cov_b11_fetchtime",
         "cov_b_fp_fr", "cov_tanker")
```

In addition to this common set of baseline covariates, we also include one or more lagged dependent variables as covariates. These change from model to model. The specific lagged variables used for each analysis are shown in the mock estimations in the hypotheses section below.

7.2 Weighting

There is some variability in the number of subjects recruited into the baseline sample in each cluster. There are also very significant differences in the number of subjects in each slum (owing to the different number of clusters per slum). We construct two sets of survey weights such that all clusters contribute equally in the estimation of Equation 1 and all slums contribute equally in the estimation of Equations 2, 3, and 4.

```r
# compute weights
  analysis_df %<>%
    group_by(slumid) %>%
      mutate(slum_wts = 1/(n())) %>%
    ungroup() %>%
    group_by(cluster_id) %>%
      mutate(clus_wts = 1/(n())) %>%
    ungroup()
```

7.3 Function

Here we present the code for the estimation function, which is flexible for use in all analyses.

```r
# estimation function
  estimates <- function(dv = NULL,
                        treat = NULL, # c("t1", "t2", "t1*t2", "t1ort2")
```

```r
                        lag_dv = NULL,
                        ex_cov = NULL,
                        mod_var = NULL,
                        pval = "two-tailed", # c("upper", "lower", "two-tailed")
                        dat = analysis_df) {

# build up the formula
  if (treat == "t1") {
    blk <- "+ as.factor(cl_block_id)"
  } else {
    blk <- "+ as.factor(block_id)"
  }

  if(is.null(mod_var)) {
    treat_main <- treat
  } else {
    treat_main <- paste0(treat, "*", mod_var)
  }

  cov5 <- c(cov, lag_dv)
  cov5 <- cov5[!cov5 %in% ex_cov] # option to remove covariates
  cov1 <- paste("+", as.character(cov5), collapse = "")
  frm_min <- as.formula(paste0(dv, "~", treat_main))
  frm_med <- as.formula(paste0(dv, "~", treat_main, blk))
  frm_max <- as.formula(paste0(dv, "~", treat_main, cov1, blk))

# define the cluster level
  if(treat=="t1") { clust <- dat[["cluster_id"]] } else { clust <- dat[["slumid"]] }

# define weights
  if(treat=="t1") { wts <- dat[["clus_wts"]] } else { wts <- dat[["slum_wts"]] }

# impute missing covariate data [we do not impute data for missing moderators]
  dat %<>%
    group_by(block_id) %>%
      mutate_at(vars(starts_with("cov_")),
            funs(ifelse(is.na(.), mean(., na.rm = T), .))) %>%
    ungroup()

# run the models [using lm_robust for cr2 errors]
  if(treat=="t1*t2") {
    # interaction models
      mod <- lm_robust(frm_max, clusters = clust, weights = wts, data = dat)
      mod$cmean <- round(lm(frm_min, weights = wts, data = dat)$coefficients[1], 3)
      mod$unadj <- coef(summary(lm_robust(frm_med, clusters = clust,
                                  weights = wts, data = dat)))["t1:t2","Estimate"]

  } else {
# uninteracted models
      mod <- lm_robust(frm_max, clusters = clust, weights = wts, data = dat)
      mod$unadj <- coef(summary(lm_robust(frm_med, clusters = clust,
                                          weights = wts, data = dat)))[2,1]
      mod$tstat <- coef(summary(mod))[2,1]/coef(summary(mod))[2,2]
```

```r
    mod$cmean <- round(lm(frm_min, weights = wts, data = dat)$coefficients[1], 3)
  }

    # recalculate the model based pvalues here with reference to the z-table
    switch(pval,
      "lower" = { mod$mainp <- round(pt(mod$tstat, mod$df[2], lower.tail = T), 3) },
      "upper" = { mod$mainp <- round(pt(mod$tstat, mod$df[2], lower.tail = F), 3) },
      "two-tailed" = { mod$mainp <- round(coef(summary(mod))[2,3], 3) } )
      if(treat=="t1*t2") { mod$mainp <-
              round(coef(summary(mod))[nrow(coef(summary(mod))),3],3) }
      if(!is.null(mod_var)) {
        mod_name <- paste0(treat,":",mod_var)
        mod$mainp <- round(coef(summary(mod))[mod_name,"Pr(>|t|)"],3) }

    # generate table object
    switch(treat,
      "t1*t2" = {mod$tab <-
                     matrix(c(round(coef(summary(mod))["t1","Estimate"], 3),
                              round(coef(summary(mod))["t1","Std. Error"], 3),
                              round(coef(summary(mod))["t2","Estimate"], 3),
                              round(coef(summary(mod))["t2","Std. Error"], 3),
                              round(coef(summary(mod))["t1:t2","Estimate"], 3),
                              round(coef(summary(mod))["t1:t2","Std. Error"], 3),
                              "", "")) },
      "t1" = {mod$tab <-
                     matrix(c(round(coef(summary(mod))["t1","Estimate"], 3),
                              round(coef(summary(mod))["t1","Std. Error"], 3),
                              "", "", "", "", "", "")) },

      "t2" = {mod$tab <-
                     matrix(c("", "",
                              round(coef(summary(mod))["t2","Estimate"], 3),
                              round(coef(summary(mod))["t2","Std. Error"], 3),
                              "", "", "", "")) },

      "t1ort2" = {mod$tab <-
                     matrix(c("", "", "", "", "", "",
                              round(coef(summary(mod))["t1ort2","Estimate"], 3),
                              round(coef(summary(mod))["t1ort2","Std. Error"], 3))) } )



  if(!is.null(mod_var)) {
    mod$tab <- rbind(mod$tab,
            matrix(c(round(coef(summary(mod))[mod_name,"Estimate"], 3),
                        round(coef(summary(mod))[mod_name,"Std. Error"], 3))))
    } else { mod$tab <- rbind(mod$tab, matrix(c("", "")) )}


      mod$tab <-  # these are the common elements of all tables
        rbind(mod$tab, matrix(c(mod$mainp, "", as.character(pval), mod$cmean, mod$N)))

# return the output
```

```
  return(mod)
}
```

7.4 Balance tests

In the analysis of experiments, it has become common to inspect whether balance exists between treated and untreated groups with respect to pre-treatment covariates. We will do so for 17 variables from the baseline survey:

- Illiterate or not
- Education level
- Income
- Assets owned
- Title deed to house
- Electricity connection
- External wall quality
- Voted in last BMC election
- Migrant status
- Caste
- Religion
- Visited by politicians
- Water scarcity
- Lighting in slum
- Paved roads in slum
- Ever paid water bill
- Time spent fetching water

```
## recode baseline variables for balance checks
## additional balance variables

# education 2: level [treats edu level as ordinal]
  analysis_df$b97_edu <- as.numeric(mock_baseline$b97)

# external wall quality [1 if brick/concrete/stone; zero otherwise]
  analysis_df$b110_wall <- ifelse((mock_baseline$b107 == "a" |
                mock_baseline$b107 == "b"| mock_baseline$b107 == "c"), 1, 0)

# lighting
  analysis_df$b29_lighting <- (mock_baseline$b29_r6_c1 == "a")*1

# paved roads
  analysis_df$b29_roads <- (mock_baseline$b29_r5_c1 == "a")*1

# specify list of variables for balance checks
  dvs_balance <- list("b97_literacy", "b97_edu", "b95_income",
        "b96_assets", "b44_patta", "b25_electricity", "b110_wall",
        "b113_voted", "b100_migrant", "b107_varna", "b105_hindu",
        "b117_polvisit", "b10_waterscarce", "b29_lighting", "b29_roads",
        "b7_waterbillever", "b11_fetchtime")
```

The results of the balance tests—which were performed before filing this PAP—are presented in a separate randomization document.

8 Outcomes

Almost all of our outcome measures will be taken from responses to the midline and endline surveys. Several outcomes are indices combining families of cognate measures. These are average z-scores, which are generated by first subtracting the control group mean for each constituent variable and then dividing by the control group standard deviation. The final index is then the average of these z-scores across the variables that compose the index (Kling, Liebman, and Katz 2007). Following convention, positively signed z-scores indicate more "beneficial" outcomes. Note that in cases where observations are missing for fewer than 50 percent of the constituent variables of the index, we impute the missing data using block-level means. In cases where observations are missing for 50 percent or more of constituent variables, the index outcome is coded as missing. The index function is as follows:

```
# function for making the z-score indexes
  make_index <- function(vlist = NULL,
                         vname = NULL) {

    # perform the calculations
      temp <- analysis_df %>%
             dplyr::select(vlist, "t1", "t2", "block_id") %>%
             mutate(na_prop = rowSums(is.na(.[,c(vlist)]))/length(vlist)) %>%
             group_by(block_id) %>%
                mutate_at(vars(vlist),
                  funs(ifelse(is.na(.), mean(., na.rm = T), .))) %>%
             ungroup() %>%
             mutate_at(vlist,
                 funs((. - mean(.[t1==0 & t2==0], na.rm = T))/sd(.[t1==0 & t2==0],
                                                           na.rm = T)))

    # attach the variable, and replace as missing if required
      analysis_df[[vname]] <- rowMeans(temp[ , c(vlist)])
      analysis_df[[vname]][temp$na_prop >= 0.5] <- NA

    # function returns the updated analysis_df
      return(analysis_df)
                }
```

9 Multiple comparisons

Besides indexing, we also specify p-value corrections to account for multiple comparisons. Because we intend to run a large number of tests, we account for the probability of obtaining false positives. We will report both nominal p-values and p-values corrected using the Benjamini and Hochberg (1995) method. We will control the false discovery rate at the 0.05 level. The correction will be applied by hypothesis family. The code used to perform the corretion is given in the section on hypothesis testing.

We distinguish three types of tests:

- **Primary**: eight primary tests that are *not* subjected to corrections.
- **Secondary**: additional tests—typically of individual index components or mechanisms—that are subject to a within-family False Discovery Rate (FDR) correction; families are defined in the hypotheses section.
- **Manipulation**: tests that the intervention was delivered to units assigned to treatment; these are *not* subject to corrections.

10 Hypotheses

We organize the project hypotheses according to the papers we plan to write. Note the hypotheses listed below will be assessed using data from the endline survey, although papers will also present the equivalent tests using midline data to investigate possible dynamic effects.

10.1 Manipulation checks

- Hm.1 (manipulation): T1 increases the likelihood of citizens receiving a visit from NGO workers helping with water access
- Hm.2 (manipulation): T2 increases the likelihood of citizens being encouraged to participate in collective action over water access

```
## measures
# visit from NGO to help with bmc connection
  analysis_df$dv.ngovisit <- (mock_endline$e_ngo_visit=="yes")*1

# personally participated in collective action over water
  analysis_df$dv.wateract.me <- (mock_endline$e_wateract_me=="yes")*1

## models [mapping onto hypotheses given in square brackets]
  mc1 <- estimates(dv = "dv.ngovisit", treat = "t1", pval = "upper") #[Hmc1]
  mc2 <- estimates(dv = "dv.wateract.me", treat = "t2", pval = "upper") #[Hmc2]

# make table
  mods <- c(mc1$tab, mc2$tab)
  dvs <- c("dv.ngovisit", "dv.wateract.me")
  correct_p <- c("", "")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:	
	dv.ngovisit	dv.wateract.me
T1 Est.	-0.016	
T1 SE	0.012	
T2 Est.		-0.041
T2 SE		0.017
T1xT2 Est.		
T1xT2 SE		
T1orT2 Est.		
T1orT2 SE		
Interaction Est.		
Interaction SE		
Nominal p-value	0.914	0.989
Corrected p-value		
Test type	upper	upper
Control mean	0.506	0.508
N	6869	6869

10.2 Paper One: Causes of formalization

- Hc.1a (primary): T1 increases the degree of formalization

- Hc.1b (primary): T1 increases full formalization
- Hc.2a (primary): The effect of T1 on the degree of formalization is more positive when T2 is also assigned
- Hc.2b (primary): The effect of T1 on full formalization is more positive when T2 is also assigned

```r
## measures
# degree of formalization
  analysis_df$dv.formalization.level <-
          case_when(mock_endline$e_formsubmitted=="no" ~ 0,
                    mock_endline$e_formsubmitted=="yes" ~ 1,
                    mock_endline$e_p_form=="yes" ~ 2,
                    mock_endline$e_bmc_connection=="yes" ~ 3)

# whether or not bmc connection received
  analysis_df$dv.formalized <- (mock_endline$e_bmc_connection=="yes")*1

## models
  p1.1a <- estimates(dv = "dv.formalization.level", treat = "t1", pval = "upper") #[Hc.1]
  p1.1b <- estimates(dv = "dv.formalized", treat = "t1", pval = "upper") #[Hc.1]
  p1.2a <- estimates(dv = "dv.formalization.level",
                    treat = "t1*t2", pval = "two-tailed") #[Hc.2]
  p1.2b <- estimates(dv = "dv.formalized", treat = "t1*t2", pval = "two-tailed") #[Hc.2]

# table
  mods <- c(p1.1a$tab, p1.1b$tab, p1.2a$tab, p1.2b$tab)
  dvs <- c(rep(c("dv.formalization.level", "dv.formalized"), 2))
  correct_p <- c(rep("", 4))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:			
	dv.formalization.level	dv.formalized	dv.formalization.level	dv.formalized
T1 Est.	-0.016	0.002	-0.022	-0.018
T1 SE	0.013	0.013	0.019	0.024
T2 Est.			-0.006	0.012
T2 SE			0.021	0.025
T1xT2 Est.			0	0.012
T1xT2 SE			0.032	0.032
T1orT2 Est.				
T1orT2 SE				
Interaction Est.				
Interaction SE				
Nominal p-value	0.877	0.453	-0.008	0.361
Corrected p-value				
Test type	upper	upper	two-tailed	two-tailed
Control mean	0.506	0.492	0.519	0.496
N	6869	6869	6869	6869

If human capital constraints are primary, then we expect the following:

- Hc.3a (secondary): The effect of T1 on formalization is more positive for less educated individuals
- Hc.4a (secondary): The effect of T1 on formalization is more positive for individuals with lower incomes
- Hc.5a (secondary): The effect of T1 on formalization is more positive for individuals from subaltern communities

If bureaucrats discriminate against marginalized groups, however, then the following would hold:

- Hc.3b (secondary): The effect of T1 on formalization is more positive for educated individuals
- Hc.4b (secondary): The effect of T1 on formalization is more positive for individuals with higher incomes
- Hc.5b (secondary): The effect of T1 on formalization is more positive for individuals not belonging to subaltern communities[7]

```r
## measures
# education: no primary education?
  analysis_df$m.no.primary <- (mock_baseline$b97 %in% c("a", "b", "c"))*1

# income
  analysis_df$m.low.income <- (mock_baseline$b95 < median(mock_baseline$b95, na.rm=T))*1

# sc/st/muslim status
  analysis_df$m.sc.st.mus <- (mock_baseline$b107 %in% c("a", "b")
                              | mock_baseline$b105=="b"
                              | mock_baseline$b99=="b")*1

## models
  p1.3 <- estimates(dv = "dv.formalized", treat = "t1",
                    mod_var = "m.no.primary", ex_cov = "cov_b97_literacy") #[Hc.3a/b]
  p1.4 <- estimates(dv = "dv.formalized", treat = "t1",
                    mod_var = "m.low.income",
                    ex_cov = c("cov_b95_income", "cov_b96_assets")) #[Hc.4a/b]
  p1.5 <- estimates(dv = "dv.formalized", treat = "t1",
                    mod_var = "m.sc.st.mus",
                    ex_cov = c("cov_b99_migrant", "cov_b105_hindu")) #[Hc.5a/b]

# table
  mods <- c(p1.3$tab, p1.4$tab, p1.5$tab)
  dvs <- c(rep("dv.formalized", 3))
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(p1.3$mainp, p1.4$mainp, p1.5$mainp))),
      method = "fdr"), 3))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

[7] Note, the table corresponding to these hypotheses jointly presents results for treatment heterogeneity according to economic, educational, and ethno-cultural factors. Yet it is theoretically imaginable that these variables impact treatment differentially. We thus leave open the possibility that we will analyze and discuss these moderators separately in our manuscript.

	Dependent variable:		
	dv.formalized	dv.formalized	dv.formalized
T1 Est.	0.008	0.005	-0.006
T1 SE	0.015	0.02	0.029
T2 Est.			
T2 SE			
T1xT2 Est.			
T1xT2 SE			
T1orT2 Est.			
T1orT2 SE			
Interaction Est.	-0.017	0.009	0.005
Interaction SE	0.027	0.026	0.033
Nominal p-value	0.538	0.743	0.872
Corrected p-value	0.872	0.872	0.872
Test type	two-tailed	two-tailed	two-tailed
Control mean	0.501	0.496	0.504
N	6869	5810	5959

- Hc.6 (secondary): The effect of T2 on formalization is more positive in slums with more social capital

```
## measures
# joint petition
  analysis_df$m.jointpetition <- (unclass(factor(mock_baseline$b53))-1)/3

# care for sick
  analysis_df$m.caresick <- (4-unclass(factor(mock_baseline$b55)))/3

# know about others
  analysis_df$m.knowothers <- (unclass(factor(mock_baseline$b56))-1)/3

# social punishment
  analysis_df$m.socialpunish <- (unclass(factor(mock_baseline$b57))-1)/3

# contribute to group pot
  analysis_df$m.socialcontribute <- (unclass(factor(mock_baseline$b58))-1)/3

# look out for welfare
  analysis_df$m.welfarecare <- (as.numeric(mock_baseline$b59)-1)/3

# shared meal with different groups
  analysis_df$m.sharemeal <- (4-unclass(factor(mock_baseline$b111)))/3

# make social capital index
  analysis_df <- make_index(vlist = c("m.jointpetition",
                                      "m.caresick",
                                      "m.knowothers",
                                      "m.socialpunish",
                                      "m.socialcontribute",
                                      "m.welfarecare",
                                      "m.sharemeal"),
                            vname = "m.social.capital")

## models
```

```r
  p1.6 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.social.capital") #[Hc.6]

# table
  mods <- c(p1.6$tab)
  dvs <- c(rep("dv.formalized", 1))
  correct_p <- c("")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.formalized
T1 Est.	
T1 SE	
T2 Est.	0.018
T2 SE	0.016
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	
T1orT2 SE	
Interaction Est.	-0.039
Interaction SE	0.044
Nominal p-value	0.376
Corrected p-value	
Test type	two-tailed
Control mean	0.487
N	6797

We have ambiguous expectations about the role played by brokers and therefore do not specify a single, directional hypothesis. If brokers help formalization:

- Hc.7a (secondary): The effect of T1 or T2 on formalization is more positive for citizens who rely on brokers

If brokers hinder formalization:

- Hc.7b (secondary): The effect of T1 or T2 on formalization is less positive for citizens who rely on brokers

```r
## measures
# contacted broker in last 6 months at baseline
  analysis_df$m.broker <- (mock_baseline$b67_i=="Yes")*1

## models
  p1.7 <- estimates(dv = "dv.formalized", treat = "t1ort2",
            pval = "two-tailed", mod_var = "m.broker") #[Hc.7a and Hc.7b]

# table
  mods <- c(p1.7$tab)
  dvs <- c("dv.formalized")
  correct_p <- c("")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.formalized
T1 Est.	
T1 SE	
T2 Est.	
T2 SE	
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	-0.014
T1orT2 SE	0.027
Interaction Est.	0.035
Interaction SE	0.041
Nominal p-value	0.4
Corrected p-value	
Test type	two-tailed
Control mean	0.526
N	5866

- Hc.8 (secondary): The effect of T2 on formalization is more positive for citizens who share the religion of the local corporator
- Hc.9: The effect of T2 on formalization is for citizens who share the ethno-linguistic background of the local corporator
- Hc.10 (secondary): The effect of T2 on formalization is more positive for slums that previously voted for the ruling party
- Hc.11 (secondary): The effect of T2 on formalization is more positive in slums with higher rates of local voter registration
- Hc.12 (secondary): The effect of T2 on formalization is more positive for slums whose local corporator belongs to the ruling party[8]

```
## measures
# co-religionist of local corporator
  analysis_df$m.coreligion <-
    (mock_baseline$b105=="b" & analysis_df$corporator_religion=="Muslim_name")*1

# co-marathi of local corporator
  analysis_df$m.comarathi <-
    (mock_baseline$b99=="a" & analysis_df$corporator_marathi==1)*1

# co-partisan of local corporator
  analysis_df$m.coparty <- (mock_baseline$b113==analysis_df$corporator_party)*1

# voter registration status
  analysis_df$m.reg.voter <- (mock_baseline$b28_h=="a")*1

# local corporator aligned with the ruling party in the BMC (shiv sena)
  analysis_df$m.corp.aligned <- analysis_df$mayors_party

## models
  p1.8 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.coreligion",
```

[8]We present the result for cultural and political heterogeneity jointly, yet it may be that these factors operate in different ways in predicting the efficacy of treatment on formalization. For example, taste-based prejudice/ethnic favoritism may affect formalization likelihood for cultural in-groups and out-groups. We therefore leave open the possibility that we will analyze and discuss these moderators separately in our manuscript.

```
                   pval = "two-tailed", ex_cov = "cov_b105_hindu") #[Hc.8]
p1.9 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.comarathi",
                   pval = "two-tailed", ex_cov = "cov_b99_migrant") #[Hc.9]
p1.10 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.coparty",
                   pval = "two-tailed") #[Hc.10]
p1.11 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.reg.voter",
                    pval = "two-tailed", ex_cov = "cov_b113_voted") #[Hc.11]
p1.12 <- estimates(dv = "dv.formalized", treat = "t2", mod_var = "m.corp.aligned",
                    pval = "two-tailed") #[Hc.12]

# table
mods <- c(p1.8$tab, p1.9$tab, p1.10$tab, p1.11$tab, p1.12$tab)
dvs <- c(rep("dv.formalized", 5))
correct_p <- c(round(p.adjust(as.numeric(as.character(
  c(p1.8$mainp, p1.9$mainp, p1.10$mainp, p1.11$mainp, p1.12$mainp))),
    method = "fdr"), 3))
make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:				
	dv.formalized	dv.formalized	dv.formalized	dv.formalized	dv.formalized
T1 Est.					
T1 SE					
T2 Est.	0.018	0.028	0.008	0.026	0.029
T2 SE	0.016	0.019	0.018	0.028	0.018
T1xT2 Est.					
T1xT2 SE					
T1orT2 Est.					
T1orT2 SE					
Interaction Est.	-0.056	-0.051	0.05	-0.013	-0.044
Interaction SE	0.049	0.048	0.052	0.038	0.04
Nominal p-value	0.273	0.292	0.342	0.723	0.282
Corrected p-value	0.428	0.428	0.428	0.723	0.428
Test type	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed
Control mean	0.487	0.486	0.491	0.474	0.481
N	6337	6266	5835	5818	6869

- Hc.13 (secondary): The effect of T1 or T2 is more positive for non-renters
- Hc. 14 (secondary): The effect of T1 or T2 is more positive for those not living on forest land or footpaths
- Hc.15 (secondary): The effect of T1 or T2 is more positive for “native” (Marathi) citizens

```
## measures
# renter dummy
analysis_df$m.renter <- (mock_baseline$b4=="b")*1

# [NOT] footpath/forest dummy
analysis_df$m.foot.forest <- (mock_baseline$b_footpath_forest=="No")*1

# Marathi dummy
analysis_df$m.marathi <- (mock_baseline$b99=="a")*1

## models
```

```r
  p1.13 <- estimates(dv = "dv.formalized", treat = "t1ort2", mod_var = "m.renter",
              pval = "two-tailed", ex_cov = c("cov_b4_renter", "cov_b44_patta")) #[Hc.13]
  p1.14 <- estimates(dv = "dv.formalized", treat = "t1ort2", mod_var = "m.foot.forest",
                     pval = "two-tailed", ex_cov = "cov_b_fp_fr") #[Hc.14]
  p1.15 <- estimates(dv = "dv.formalized", treat = "t1ort2", mod_var = "m.marathi",
                     pval = "two-tailed", ex_cov = "cov_b99_migrant") #[Hc.15]

# table
  mods <- c(p1.13$tab, p1.14$tab, p1.15$tab)
  dvs <- c(rep("dv.formalized", 3))
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(p1.13$mainp, p1.14$mainp, p1.15$mainp))),
      method = "fdr"), 3))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:		
	dv.formalized	dv.formalized	dv.formalized
T1 Est.			
T1 SE			
T2 Est.			
T2 SE			
T1xT2 Est.			
T1xT2 SE			
T1orT2 Est.	0.012	0.012	0.009
T1orT2 SE	0.033	0.024	0.025
Interaction Est.	-0.006	-0.013	-0.022
Interaction SE	0.041	0.044	0.041
Nominal p-value	0.876	0.773	0.587
Corrected p-value	0.876	0.876	0.876
Test type	two-tailed	two-tailed	two-tailed
Control mean	0.485	0.493	0.51
N	5802	5830	5847

- Hc.16 (secondary): The effect of T1 or T2 creates backlash by vested interests

```r
## measures
# negative visit by vested interests
  analysis_df$dv.backlash <- (mock_endline$e_vested_interests=="yes")*1

## models
  p1.16 <- estimates(dv = "dv.backlash", treat = "t1ort2",
                     pval = "upper", ex_cov = "cov_tanker") #[Hc.16]

# table
  mods <- c(p1.16$tab)
  dvs <- c("dv.backlash")
  correct_p <- c("")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.backlash
T1 Est.	
T1 SE	
T2 Est.	
T2 SE	
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	-0.001
T1orT2 SE	0.018
Interaction Est.	
Interaction SE	
Nominal p-value	0.516
Corrected p-value	
Test type	upper
Control mean	0.502
N	6869

10.3 Paper Two: Formalization and attitudes/behaviors with respect to the state and politics

- Ha.1 (primary): T1 or T2 improves attitudes about the bureaucracy and electoral politics
  - Ha.1.i (secondary): T1 or T2 improves trust in the BMC
  - Ha.1.ii (secondary): T1 or T2 improves beliefs about the accountability of the BMC
  - Ha.1.iii (secondary): T1 or T2 improves beliefs about the competence of the BMC
  - Ha.1.iv (secondary): T1 or T2 improves beliefs about how corrupt is the BMC
  - Ha.1.v (secondary): T1 or T2 improves trust in elected politicians
  - Ha.1.vi (secondary): T1 or T2 improves beliefs about the accountability of elected politicians
  - He.1.vii (secondary): T1 or T2 improves faith in democracy

```
## measures
# trust in the mumbai municipal corporation (bmc)
  analysis_df$dv.bmctrust <- (4-as.numeric(mock_endline$e35_c))/3

# accountability of the BMC
  analysis_df$dv.bmc.accountable <- (4-unclass(factor(mock_endline$e_bmc_accountable)))/3

# competence [question asks about the "local government"]
  analysis_df$dv.competence <- (mock_endline$e38_a=="i.")*1

# corrpution [question asks about "local officials"]
  analysis_df$dv.corruption <- (unclass(factor(mock_endline$e36_b))-1)/4

# trust in elected politicians
  analysis_df$dv.poltrust <- (mock_endline$e_trust_b-1)/3

# beliefs in accountability of politicians
  analysis_df$dv.pols.accountable <-
    (4-unclass(factor(mock_endline$e_pols_accountable)))/3

# faith in democracy
  analysis_df$dv.demfaith <- (4-unclass(factor(mock_endline$e_demfaith)))/3
```

```r
# join attitudes index
  analysis_df <- make_index(vlist = c("dv.bmctrust",
                                     "dv.bmc.accountable",
                                     "dv.competence",
                                     "dv.corruption",
                                     "dv.poltrust",
                                     "dv.pols.accountable",
                                     "dv.demfaith"),
                           vname = "dv.attitudes.index")

# lagged dv: trust in the mumbai municipal corporation (bmc)
  analysis_df$cov_bmctrust <- (4-as.numeric(mock_baseline$b35_c))/3

# lagged dv: competence [question asks about the "local government"]
  analysis_df$cov_competence <- (mock_baseline$b38_a=="i.")*1

# lagged dv: corrpution [question asks about "local officials"]
  analysis_df$cov_corruption <- (unclass(factor(mock_baseline$b36_b))-1)/4

## models
  at1 <- estimates(dv = "dv.attitudes.index", treat = "t1ort2", pval = "upper",
                  lag_dv = c("cov_bmctrust", "cov_competence", "dv.corruption")) #[Ha.1]
  at2 <- estimates(dv = "dv.bmctrust", treat = "t1ort2", pval = "upper",
                  lag_dv = "cov_bmctrust") #[Ha.1.i]
  at3 <- estimates(dv = "dv.bmc.accountable", treat = "t1ort2", pval = "upper") #[Ha.1.ii]
  at4 <- estimates(dv = "dv.competence", treat = "t1ort2", pval = "upper",
                  lag_dv = "cov_competence") #[Ha.1.iii]
  at5 <- estimates(dv = "dv.corruption", treat = "t1ort2", pval = "upper",
                  lag_dv = "cov_corruption") #[Ha.1.iv]
  at6 <- estimates(dv = "dv.poltrust", treat = "t1ort2", pval = "upper") #[Ha.1.v]
  at7 <- estimates(dv = "dv.pols.accountable", treat = "t1ort2", pval = "upper") #[Ha.1.vi]
  at8 <- estimates(dv = "dv.demfaith", treat = "t1ort2", pval = "upper") #[Ha.1.vii]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(at2$mainp, at3$mainp, at4$mainp, at5$mainp))),
      method = "fdr"), 3), round(p.adjust(as.numeric(as.character(
    c(at6$mainp, at7$mainp, at8$mainp))),
      method = "fdr"), 3))

# make table
  mods <- c(at1$tab, at2$tab, at3$tab, at4$tab, at5$tab, at6$tab, at7$tab, at8$tab)
  dvs <- c("dv.attitudes.index",
           "dv.bmctrust",
           "dv.bmc.accountable",
           "dv.competence",
           "dv.corruption",
           "dv.poltrust",
           "dv.pols.accountable",
           "dv.demfaith")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

	Dependent variable:							
	dv.attitudes.index	dv.bmctrust	dv.bmc.accountable	dv.competence	dv.corruption	dv.poltrust	dv.pols.accountable	dv.demfaith
T1 Est.								
T1 SE								
T2 Est.								
T2 SE								
T1xT2 Est.								
T1xT2 SE								
T1orT2 Est.	-0.009	-0.017	-0.013	0.004	-0.008	-0.007	0.01	-0.001
T1orT2 SE	0.015	0.013	0.013	0.02	0.014	0.013	0.015	0.02
Interaction Est.								
Interaction SE								
Nominal p-value	0.732	0.9	0.836	0.431	0.713	0.712	0.261	0.516
Corrected p-value		0.9	0.9	0.9	0.9	0.712	0.712	0.712
Test type	upper	upper	upper	upper	upper	upper	upper	upper
Control mean	0.003	0.512	0.506	0.501	0.51	0.503	0.499	0.504
N	6869	6869	6869	6869	6869	6869	6869	6869

- He.2 (primary): T1 or T2 increases engagement with the bureaucracy and politics
  - He.2.i (secondary): T1 or T2 increases likelihood of sending SMS requesting help from BMC
  - He.2.ii (secondary): T1 or T2 increases rates of contact with the bureaucracy
  - He.2.iii (secondary): T1 or T2 increases political knowledge
  - He.2.iv (secondary): T1 or T2 increases likelihood of turning out to vote
  - He.2.v (secondary): T1 or T2 increases non-electoral political participation
  - He.2.vi (secondary): T1 or T2 increases rates of contacting politicians

```
## measures
# text message sent [behavioral measure in survey]
  analysis_df$dv.textsent <- (mock_endline$e_sms_sent=="yes")*1

# self-reported contacting
  analysis_df$dv.bur.contact <- (mock_endline$e_bur_contact=="yes")*1

# political knowledge
  analysis_df$dv.polknow <-
    rowSums(mock_endline[grep("e64_", names(mock_endline))]=="Correct",
            na.rm = TRUE)/3

# turnout likelihood
  analysis_df$dv.turnout <- (4-unclass(factor(mock_endline$e65)))/3

# informal participation (additive index)
  analysis_df$dv.infpartic <-
    rowSums(mock_endline[grep("e68_", names(mock_endline))] == "i.", na.rm = TRUE)/7

# contacting (additive index)
  analysis_df$dv.polcontact <-
    rowSums(mock_endline[grep("e67_", names(mock_endline))] == "Yes", na.rm = TRUE)/7

# join engagement index
  analysis_df <- make_index(vlist = c("dv.textsent",
                                      "dv.bur.contact",
                                      "dv.polknow",
                                      "dv.turnout",
                                      "dv.infpartic",
                                      "dv.polcontact"),
                            vname = "dv.engage.index")

# lagged dv: political knowledge
  analysis_df$cov_polknow <-
```

```r
    rowSums(mock_baseline[grep("b64_", names(mock_baseline))]=="Correct",
            na.rm = TRUE)/3

# lagged dv: turnout likelihood
  analysis_df$cov_turnout <- (4-unclass(factor(mock_baseline$b65)))/3

# lagged dv: informal participation (additive index)
  analysis_df$cov_infpartic <-
    rowSums(mock_baseline[grep("b68_", names(mock_baseline))] == "i.", na.rm = TRUE)/7

# lagged dv: contacting (additive index)
  analysis_df$cov_polcontact <-
    rowSums(mock_baseline[grep("b67_", names(mock_baseline))] == "Yes", na.rm = TRUE)/7

## models
  en1 <- estimates(dv = "dv.engage.index", treat = "t1ort2", pval = "upper",
                   lag_dv = c("cov_polknow", "cov_turnout", "cov_infpartic",
                              "cov_polcontact")) #[He.2]
  en2 <- estimates(dv = "dv.textsent", treat = "t1ort2", pval = "upper") #[He.2.i]
  en3 <- estimates(dv = "dv.bur.contact", treat = "t1ort2", pval = "upper") #[He.2.ii]
  en4 <- estimates(dv = "dv.polknow", treat = "t1ort2", pval = "upper",
                   lag_dv = "cov_polknow") #[He.2.iii]
  en5 <- estimates(dv = "dv.turnout", treat = "t1ort2", pval = "upper",
                   lag_dv = "cov_turnout") #[He.2.iv]
  en6 <- estimates(dv = "dv.infpartic", treat = "t1ort2", pval = "upper",
                   lag_dv = "cov_infpartic") #[He.2.v]
  en7 <- estimates(dv = "dv.polcontact", treat = "t1ort2", pval = "upper",
                   lag_dv = "cov_polcontact") #[He.2.vi]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(en2$mainp, en3$mainp, en4$mainp, en5$mainp, en6$mainp, en7$mainp))), method = "fdr"), 3))

# make table
  mods <- c(en1$tab, en2$tab, en3$tab, en4$tab, en5$tab, en6$tab, en7$tab)
  dvs <- c("dv.engage.index",
           "dv.textsent",
           "dv.bur.contact",
           "dv.polknow",
           "dv.turnout",
           "dv.infpartic",
           "dv.polcontact")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

	Dependent variable:						
	dv.engage.index	dv.textsent	dv.bur.contact	dv.polknow	dv.turnout	dv.infpartic	dv.polcontact
T1 Est.							
T1 SE							
T2 Est.							
T2 SE							
T1xT2 Est.							
T1xT2 SE							
T1orT2 Est.	-0.008	0	-0.015	0.006	0.003	0.002	-0.012
T1orT2 SE	0.013	0.015	0.017	0.01	0.011	0.007	0.008
Interaction Est.							
Interaction SE							
Nominal p-value	0.718	0.505	0.803	0.261	0.409	0.411	0.92
Corrected p-value		0.758	0.92	0.758	0.758	0.758	0.92
Test type	upper	upper	upper	upper	upper	upper	upper
Control mean	-0.003	0.487	0.513	0.497	0.499	0.5	0.711
N	6869	6869	6869	6869	6869	6869	6869

- Ht.3 (primary): T1 or T2 increases tax morale and fee compliance
  - Ht.3.i (secondary): T1 or T2 increases tax morale
  - Ht.3.ii (secondary): T1 or T2 increases expectations of punishment for non-compliance
  - Ht.3.iii (secondary): T1 or T2 increases electricity payments
  - Ht.3.iv (secondary): T1 or T2 increases water payments

```r
## measures
# morale
    analysis_df$dv.morale <-
        case_when(
          mock_endline$e_morale_a=="a" & mock_endline$e_morale_b=="a" ~ 4,
          mock_endline$e_morale_a=="a" & mock_endline$e_morale_b=="b" ~ 3,
          mock_endline$e_morale_a=="b" & mock_endline$e_morale_b=="b" ~ 2,
          mock_endline$e_morale_a=="b" & mock_endline$e_morale_b=="a" ~ 1 )

# enforcement expectations
  analysis_df$dv.willpunish <- (unclass(factor(mock_endline$e_comply_c))-1)/3

# shows enumerator stamped electricity payment
  analysis_df$dv.elecpay <- (mock_endline$e_showelecbill=="yes")*1

# shows enumerator paid water bill
  analysis_df$dv.waterpay <- (mock_endline$e_showelecbill=="yes")*1

# tax index
  analysis_df <- make_index(vlist = c("dv.morale",
                                      "dv.willpunish",
                                      "dv.elecpay",
                                      "dv.waterpay"),
                            vname = "dv.tax.index")

## models
  ta1 <- estimates(dv = "dv.tax.index", treat = "t1ort2", pval = "upper") #[Ht.3]
  ta2 <- estimates(dv = "dv.morale", treat = "t1ort2", pval = "upper") #[Ht.3.i]
  ta3 <- estimates(dv = "dv.willpunish", treat = "t1ort2", pval = "upper") #[Ht.3.ii]
  ta4 <- estimates(dv = "dv.elecpay", treat = "t1ort2", pval = "upper") #[Ht.3.iii]
  ta5 <- estimates(dv = "dv.waterpay", treat = "t1ort2", pval = "upper") #[Ht.3.iv]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(ta2$mainp, ta3$mainp, ta4$mainp, ta5$mainp))), method = "fdr"), 3))
```

```r
# make table
  mods <- c(ta1$tab, ta2$tab, ta3$tab, ta4$tab, ta5$tab)
  dvs <- c("dv.tax.index",
           "dv.morale",
           "dv.willpunish",
           "dv.elecpay",
           "dv.waterpay")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:				
	dv.tax.index	dv.morale	dv.willpunish	dv.elecpay	dv.waterpay
T1 Est.					
T1 SE					
T2 Est.					
T2 SE					
T1xT2 Est.					
T1xT2 SE					
T1orT2 Est.	0.002	-0.003	-0.005	0.005	0.005
T1orT2 SE	0.019	0.042	0.014	0.017	0.017
Interaction Est.					
Interaction SE					
Nominal p-value	0.468	0.528	0.625	0.375	0.375
Corrected p-value		0.625	0.625	0.625	0.625
Test type	upper	upper	upper	upper	upper
Control mean	0.003	2.508	0.496	0.501	0.501
N	6869	6869	6869	6869	6869

- Ht.4 (secondary): T1 or T2 improves quality of water access

```r
## measures
# "successful formalization" index: amount consumed
  analysis_df$dv.amount.water <- mock_endline$e_amount_drunk

# "successful formalization" index: amount spent on drinking water
  analysis_df$dv.drinkwater.spend <- mock_endline$e_drinkwater_spend

# "successful formalization" index: time collecting
  analysis_df$dv.time.water <-
    rowMeans(mock_endline[grep("e_timewait_", names(mock_endline))], na.rm = TRUE)

# "successful formalization" index: distance to collection point
  analysis_df$dv.distance.water <-
        case_when(
            mock_endline$e6_r1_c2=="a" & mock_endline$e6_r1_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r2_c2=="a" & mock_endline$e6_r2_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r3_c2=="a" & mock_endline$e6_r3_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r4_c2=="a" & mock_endline$e6_r4_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r5_c2=="a" & mock_endline$e6_r5_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r6_c2=="a" & mock_endline$e6_r6_c6 %in% c("a", "b") ~ 1,
            mock_endline$e6_r7_c2=="a" & mock_endline$e6_r7_c6 %in% c("a", "b") ~ 1,
            TRUE ~ 0)
```

```r
# lagged dv: amount consumed
  analysis_df$cov_amount.water <- mock_baseline$b9

# lagged dv: time collecting
  analysis_df$cov_time.water <-
    rowMeans(mock_baseline[grep("b11_", names(mock_baseline))], na.rm = TRUE)

# lagged dv: distance traveled
  analysis_df$cov_distance.water <-
        case_when(
            mock_baseline$b6_r1_c2=="a" & mock_baseline$b6_r1_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r2_c2=="a" & mock_baseline$b6_r2_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r3_c2=="a" & mock_baseline$b6_r3_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r4_c2=="a" & mock_baseline$b6_r4_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r5_c2=="a" & mock_baseline$b6_r5_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r6_c2=="a" & mock_baseline$b6_r6_c6 %in% c("a", "b") ~ 1,
            mock_baseline$b6_r7_c2=="a" & mock_baseline$b6_r7_c6 %in% c("a", "b") ~ 1,
            TRUE ~ 0)

# generate index
  analysis_df <- make_index(vlist = c("dv.amount.water",
                                      "dv.drinkwater.spend",
                                      "dv.time.water",
                                      "dv.distance.water"),
                            vname = "dv.water.quality.index")

## models
  ta6 <- estimates(dv = "dv.water.quality.index", treat = "t1ort2", pval = "upper",
          lag_dv = c("cov_amount.water", "cov_time.water", "cov_distance.water"),
          ex_cov = c("cov_b11_fetchtime")) #[Ht.4]

# p-value correction
  correct_p <- c("")

# make table
  mods <- c(ta6$tab)
  dvs <- c("dv.water.quality.index")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.water.quality.index
T1 Est.	
T1 SE	
T2 Est.	
T2 SE	
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	0.001
T1orT2 SE	0.011
Interaction Est.	
Interaction SE	
Nominal p-value	0.474
Corrected p-value	
Test type	upper
Control mean	0.007
N	6868

- Ht.5 (secondary): T1 or T2 increases individuals' satisfaction with the BMC's performance in providing water
- Ht.6 (secondary): T1 or T2 increases individuals' sense of political efficacy
- Ht.7 (secondary): T1 or T2 increases individuals' sense of reciprocity toward the state
- Ht.8 (secondary): T1 or T2 increases individuals' belief that the state can monitor non-compliance
- Ht.9 (secondary): T1 or T2 increases individuals' disposable income

```
## measures
# water access satisfaction
  analysis_df$dv.bmcwater.satisfy <-
  (unclass(factor(mock_endline$e_bmcwater_satisfy))-1)/3

# political efficacy
  analysis_df$dv.efficacy <- (unclass(factor(mock_endline$e_efficacy))-1)/3

# reciprocity
  analysis_df$dv.reciprocity <- (unclass(factor(mock_endline$e_reciprocity))-1)/3

# disposable income
  analysis_df$dv.disposable.income <-
    (mock_endline$e39=="a" | mock_endline$e40=="a")*1

# monitoring perception
  analysis_df$dv.monitoring <- (unclass(factor(mock_endline$e_monitoring))-1)/3

# lagged dv: political efficacy
  analysis_df$cov_efficacy <- (unclass(factor(mock_baseline$b66))-1)/3

# lagged dv: disposable income
  analysis_df$cov_disposable.income <-
    (mock_baseline$b39=="a" | mock_baseline$b40=="a")*1

## models
  ta7 <- estimates(dv = "dv.bmcwater.satisfy", treat = "t1ort2", pval = "upper") #[Ht.5]
  ta8 <- estimates(dv = "dv.efficacy", treat = "t1ort2", pval = "upper",
```

```
                    lag_dv = "cov_efficacy") #[Ht.6]
  ta9 <- estimates(dv = "dv.reciprocity", treat = "t1ort2", pval = "upper") #[Ht.7]
  ta10 <- estimates(dv = "dv.monitoring", treat = "t1ort2", pval = "upper") #[Ht.8]
  ta11 <- estimates(dv = "dv.disposable.income", treat = "t1ort2", pval = "upper",
                     lag_dv = "cov_disposable.income") #[Ht.9]

# p-value correction
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(ta7$mainp, ta8$mainp, ta9$mainp, ta10$mainp, ta11$mainp))), method = "fdr"), 3))

# make table
  mods <- c(ta7$tab, ta8$tab, ta9$tab, ta10$tab, ta11$tab)
  dvs <- c("dv.bmcwater.satisfy",
           "dv.efficacy",
           "dv.reciprocity",
           "dv.monitoring",
           "dv.disposable.income")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:				
	dv.bmcwater.satisfy	dv.efficacy	dv.reciprocity	dv.monitoring	dv.disposable.income
T1 Est.					
T1 SE					
T2 Est.					
T2 SE					
T1xT2 Est.					
T1xT2 SE					
T1orT2 Est.	-0.005	0.016	-0.014	-0.002	0.007
T1orT2 SE	0.014	0.013	0.012	0.015	0.017
Interaction Est.					
Interaction SE					
Nominal p-value	0.647	0.115	0.861	0.561	0.34
Corrected p-value	0.809	0.575	0.861	0.809	0.809
Test type	upper	upper	upper	upper	upper
Control mean	0.505	0.479	0.495	0.5	0.742
N	6869	6869	6869	6869	6869

- Ht.10 (secondary): The effect of T1 or T2 on attitudes about the bureaucracy and electoral politics is more negative for citizens living on forest land or in footpath slums.

```
## models
  ta12 <- estimates(dv = "dv.attitudes.index", treat = "t1ort2", pval = "two-tailed",
                     lag_dv = c("cov_bmctrust", "cov_competence", "dv.corruption"),
                     ex_cov = "cov_b_fp_fr", mod_var = "m.foot.forest") #[Ht.10]


# p-value correction
  correct_p <- c("")

# make table
  mods <- c(ta12$tab)
  dvs <- c("dv.attitudes.index")
```

```r
make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.attitudes.index
T1 Est.	
T1 SE	
T2 Est.	
T2 SE	
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	-0.011
T1orT2 SE	0.022
Interaction Est.	-0.005
Interaction SE	0.03
Nominal p-value	0.879
Corrected p-value	
Test type	two-tailed
Control mean	0.013
N	5830

Note, we are pregistering hypotheses that examine the effect of receiving *any* treatment (either T1 or T2) on outcomes. Yet we may also present exploratory analyses separating out the impacts of T1 and T2 in the event, say, that one of the interventions proves ineffective. 2 in exploratory analyses.

10.4 Paper Three: Welfare consequences

- Hwb.1 (primary): T1 or T2 improves women's empowerment
  - Hwb.1.i (secondary): T1 or T2 increases women's desire to seek employment
  - Hwb.1.ii (secondary): T1 or T2 increases paid work by women
  - Hwb.1.iii (secondary): T1 or T2 increases voluntary work by women
  - Hwb.1.iv (secondary): T1 or T2 reduces the amount of time women spend collecting water
  - Hwb.1.v (secondary): T1 or T2 increases women's leisure time
  - Hwb.1.vi (secondary): T1 or T2 increases women's amount of cash in hand

```r
## measures
# women's desire to seek employment
  analysis_df$dv.w.seek.employ <- (unclass(factor(mock_endline$e_w_seek_employment)))/3

# does female respondent does any paid work
  analysis_df$dv.w.anypaid <- (mock_endline$e78=="a")*1

# does female respondent does any volunteer work
  analysis_df$dv.w.volunteer <- (mock_endline$e_volunteer=="a")*1

# how much time do women spend collecting water [made negative to point in same direction]
  analysis_df$dv.women.time.water <-
    -rowMeans(mock_endline[,c("e11_a", "e11_c")], na.rm = TRUE)

# women's leisure time
  analysis_df$dv.w.leisure <- mock_endline$e80
```

```r
# do female respondents have more cash in hand than a year ago
  analysis_df$dv.w.morecash <- (mock_endline$e82=="a")*1

# women's empowerment index
  analysis_df <- make_index(vlist = c("dv.w.seek.employ",
                                      "dv.w.anypaid",
                                      "dv.w.volunteer",
                                      "dv.women.time.water",
                                      "dv.w.leisure",
                                      "dv.w.morecash"),
                            vname = "dv.womens.index")

## models
  wo1 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "upper") #[Hwb.1]
  wo2 <- estimates(dv = "dv.w.seek.employ", treat = "t1ort2", pval = "upper") #[Hwb.1.i]
  wo3 <- estimates(dv = "dv.w.anypaid", treat = "t1ort2", pval = "upper") #[Hwb.1.ii]
  wo4 <- estimates(dv = "dv.w.volunteer", treat = "t1ort2", pval = "upper") #[Hwb.1.iii]
  wo5 <- estimates(dv = "dv.women.time.water",
                   treat = "t1ort2", pval = "upper") #[Hwb.1.iv]
  wo6 <- estimates(dv = "dv.w.leisure", treat = "t1ort2", pval = "upper") #[Hwb.1.v]
  wo7 <- estimates(dv = "dv.w.morecash", treat = "t1ort2", pval = "upper") #[Hwb.1.vi]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(wo2$mainp, wo3$mainp, wo4$mainp, wo5$mainp, wo6$mainp, wo7$mainp))),
    method = "fdr"), 3))

# make table
  mods <- c(wo1$tab, wo2$tab, wo3$tab, wo4$tab, wo5$tab, wo6$tab, wo7$tab)
  dvs <- c("dv.womens.index",
           "dv.w.seek.employ",
           "dv.w.anypaid",
           "dv.w.volunteer",
           "dv.women.time.water",
           "dv.w.leisure",
           "dv.w.morecash")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

	Dependent variable:						
	dv.womens.index	dv.w.seek.employ	dv.w.anypaid	dv.w.volunteer	dv.women.time.water	dv.w.leisure	dv.w.morecash
T1 Est.							
T1 SE							
T2 Est.							
T2 SE							
T1xT2 Est.							
T1xT2 SE							
T1orT2 Est.	-0.003	0.009	0.014	-0.002	19.775	-0.471	-0.008
T1orT2 SE	0.016	0.014	0.021	0.016	58.022	0.213	0.021
Interaction Est.							
Interaction SE							
Nominal p-value	0.575	0.25	0.248	0.541	0.368	0.982	0.647
Corrected p-value		0.736	0.736	0.776	0.736	0.982	0.776
Test type	upper	upper	upper	upper	upper	upper	upper
Control mean	-0.002	0.831	0.48	0.5	-5139.744	12.21	0.515
N	6864	6869	6869	6869	6711	5808	5843

- Hwb.2 (secondary): The effect of T1 or T2 on women's empowerment is more positive for women who spent more time on water collection at baseline
- Hwb.3 (secondary): The effect of T1 or T2 on women's empowerment is more positive for less educated

women
- Hwb.4 (secondary): The effect of T1 or T2 on women's empowerment is more positive for low-income households
- Hwb.5 (secondary): The effect of T1 or T2 on women's empowerment is more positive for SC/ST women
- Hwb.6 (secondary): The effect of T1 or T2 on women's empowerment is more positive for Muslim women
- Hwb.7 (secondary): The effect of T1 or T2 on women's empowerment is more positive for migrant women[9]

```r
## measures
# time spent on water collection by women at baseline
  analysis_df$m.women.time.water <-
    rowMeans(mock_baseline[,c("b11_a", "b11_c")], na.rm = TRUE)

# sc/st dummy
  analysis_df$m.scst <- ifelse((mock_baseline$b107 == "a"
                             | mock_baseline$b107 == "b"), 1, 0)

# muslim dummy
  analysis_df$m.muslim <- (mock_baseline$b105=="b")*1

# migrant
  analysis_df$m.migrant <- (mock_baseline$b99=="b")*1

## models
  wh1 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.women.time.water", ex_cov = "cov_b11_fetchtime") #[Hwb.2]
  wh2 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.no.primary", ex_cov = "cov_b97_literacy") #[Hwb.3]
  wh3 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.low.income", ex_cov = "cov_b95_income") #[Hwb.4]
  wh4 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.scst") #[Hwb.5]
  wh5 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.muslim", ex_cov = "cov_b105_hindu") #[Hwb.6]
  wh6 <- estimates(dv = "dv.womens.index", treat = "t1ort2", pval = "two-tailed",
              mod_var = "m.migrant", ex_cov = "cov_b99_migrant") #[Hwb.7]


# p-value correction
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(wh1$mainp, wh2$mainp, wh3$mainp, wh4$mainp,
      wh5$mainp, wh6$mainp))), method = "fdr"), 3))

# make table
  mods <- c(wh1$tab, wh2$tab, wh3$tab, wh4$tab, wh5$tab, wh6$tab)
  dvs <- c(rep("dv.womens.index", 6))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

[9] As above (footnotes 7 and 8), we may elect to analyze and discuss economic, educational, and cultural heterogeneity separately.

	Dependent variable:					
	dv.womens.index	dv.womens.index	dv.womens.index	dv.womens.index	dv.womens.index	dv.womens.index
T1 Est.						
T1 SE						
T2 Est.						
T2 SE						
T1xT2 Est.						
T1xT2 SE						
T1orT2 Est.	-0.08	0	-0.017	-0.007	-0.001	-0.029
T1orT2 SE	0.033	0.025	0.025	0.024	0.022	0.021
Interaction Est.	0	-0.009	0.023	0.026	-0.036	0.051
Interaction SE	0	0.039	0.034	0.034	0.054	0.03
Nominal p-value	0.016	0.82	0.505	0.449	0.515	0.097
Corrected p-value	0.096	0.82	0.618	0.618	0.618	0.291
Test type	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed
Control mean	0.428	-0.002	0.02	-0.006	-0.005	0.009
N	6711	6864	5806	5800	5822	5843

- Hwa.1 (primary): T1 or T2 improves women's beliefs about women's empowerment
  - Hwa.1.i (secondary): T1 or T2 reduces women asking their husbands' permission to contact politicians
  - Hwa.1.ii (secondary): T1 or T2 increases women's willingness to petition politicians about women's issues
  - Hwa.1.iii (secondary): T1 or T2 increases women's decisionmaking within the household
  - Hwa.1.iv (secondary): T1 or T2 increases women's belief that women should have the right to leave a marriage
  - Hwa.1.v (secondary): T1 or T2 increases the age at which women believe daughters should marry
  - Hwa.1.vi (secondary): T1 or T2 increases women's beliefs that boys and girls should be educated equally
  - Hwa.1.vii (secondary): T1 or T2 decreases women's beliefs that husbands should always be obeyed

```r
## measures
# permission to contact politician
  analysis_df$dv.w.contactperm <- (mock_endline$e83=="b")*1

# willing to contact pol about women's issue
  analysis_df$dv.w.contactrewom <- (mock_endline$e84=="a")*1

# decision making by women in hh (additive index)
  analysis_df$dv.w.hhdecisions <-
    rowSums(mock_endline[grep("e85_",
              names(mock_endline))] == c("i.", "iv.", "v.") , na.rm = TRUE)/3

# free choice to leave marriage
  analysis_df$dv.w.leavemarriage <- (4-unclass(factor(mock_endline$e86)))/4

# daughter marriage age [dummy for NOT the youngest category]
  analysis_df$dv.daughtermarryage <- (!mock_endline$e87=="a")*1

# boys should be educated more than girls (dummy for NOT this belief)
  analysis_df$dv.educategirls <- (!mock_endline$e89=="b")*1

# obey husbands wishes always [dummy for non-agreement]
  analysis_df$dv.w.obeywishes <- (unclass(factor(mock_endline$e90))-1)/3

# women's beliefs in women's empowerment index
  analysis_df <- make_index(vlist = c("dv.w.contactperm",
                                      "dv.w.contactrewom",
                                      "dv.w.hhdecisions",
                                      "dv.w.leavemarriage",
```

```r
                                      "dv.daughtermarryage",
                                      "dv.educategirls",
                                      "dv.w.obeywishes"),
                            vname = "dv.w.beliefs.index")

## models
  wa1 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "upper") #[Hwa.1]
  wa2 <- estimates(dv = "dv.w.contactperm", treat = "t1ort2", pval = "upper") #[Hwa.1.i]
  wa3 <- estimates(dv = "dv.w.contactrewom", treat = "t1ort2", pval = "upper") #[Hwa.1.ii]
  wa4 <- estimates(dv = "dv.w.hhdecisions", treat = "t1ort2", pval = "upper") #[Hwa.1.iii]
  wa5 <- estimates(dv = "dv.w.leavemarriage", treat = "t1ort2", pval = "upper") #[Hwa.1.iv]
  wa6 <- estimates(dv = "dv.daughtermarryage", treat = "t1ort2", pval = "upper") #[Hwa.1.v]
  wa7 <- estimates(dv = "dv.educategirls", treat = "t1ort2", pval = "upper") #[Hwa.1.vi]
  wa8 <- estimates(dv = "dv.w.obeywishes", treat = "t1ort2", pval = "upper") #[Hwa.1.vii]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(wa2$mainp, wa3$mainp, wa4$mainp, wa5$mainp, wa6$mainp,
      wa7$mainp, wa8$mainp))), method = "fdr"), 3))

# make table
  mods <- c(wa1$tab, wa2$tab, wa3$tab, wa4$tab, wa5$tab, wa6$tab, wa7$tab, wa8$tab)
  dvs <- c("dv.w.beliefs.index",
           "dv.w.contactperm",
           "dv.w.contactrewom",
           "dv.w.hhdecisions",
           "dv.w.leavemarriage",
           "dv.daughtermarryage",
           "dv.educategirls",
           "dv.w.obeywishes")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 4)
```

	Dependent variable:							
	dv.w.beliefs.index	dv.w.contactperm	dv.w.contactrewom	dv.w.hhdecisions	dv.w.leavemarriage	dv.daughtermarryage	dv.educategirls	dv.w.obeywishes
T1 Est.								
T1 SE								
T2 Est.								
T2 SE								
T1xT2 Est.								
T1xT2 SE								
T1orT2 Est.	-0.009	-0.007	-0.015	0.006	-0.015	0.018	-0.015	-0.004
T1orT2 SE	0.01	0.019	0.022	0.007	0.012	0.013	0.019	0.013
Interaction Est.								
Interaction SE								
Nominal p-value	0.8	0.646	0.743	0.203	0.879	0.092	0.773	0.609
Corrected p-value		0.879	0.879	0.71	0.879	0.644	0.879	0.879
Test type	upper	upper	upper	upper	upper	upper	upper	upper
Control mean	0	0.518	0.503	0.166	0.386	0.72	0.685	0.5
N	6833	5854	5807	6869	5850	5848	5858	5859

- Hwa.2 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for women who spent more time on water collection at baseline
- Hwa.3 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for less educated women
- Hwa.4 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for low-income households
- Hwa.5 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for SC/ST women
- Hwa.6 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for Muslim women

- Hwa.7 (secondary): The effect of T1 or T2 on women's beliefs about female empowerment is more positive for migrant women[10]

```
## measures
## models
  wbh1 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.women.time.water", ex_cov = "cov_b11_fetchtime") #[Hwa.2]
  wbh2 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.no.primary", ex_cov = "cov_b97_literacy") #[Hwa.3]
  wbh3 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.low.income", ex_cov = "cov_b95_income") #[Hwa.4]
  wbh4 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.scst") #[Hwa.5]
  wbh5 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.muslim", ex_cov = "cov_b105_hindu") #[Hwa.6]
  wbh6 <- estimates(dv = "dv.w.beliefs.index", treat = "t1ort2", pval = "two-tailed",
                  mod_var = "m.migrant", ex_cov = "cov_b99_migrant") #[Hwa.7]



# p-value correction
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(wbh1$mainp, wbh2$mainp, wbh3$mainp, wbh4$mainp,
      wbh5$mainp, wbh6$mainp))), method = "fdr"), 3))

# make table
  mods <- c(wbh1$tab, wbh2$tab, wbh3$tab, wbh4$tab, wbh5$tab, wbh6$tab)
  dvs <- c(rep("dv.w.beliefs.index", 6))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

	Dependent variable:					
	dv.w.beliefs.index	dv.w.beliefs.index	dv.w.beliefs.index	dv.w.beliefs.index	dv.w.beliefs.index	dv.w.beliefs.index
T1 Est.						
T1 SE						
T2 Est.						
T2 SE						
T1xT2 Est.						
T1xT2 SE						
T1orT2 Est.	0.002	-0.022	0.012	-0.021	-0.019	-0.021
T1orT2 SE	0.032	0.014	0.021	0.016	0.012	0.019
Interaction Est.	0	0.037	-0.036	0.021	0.021	0.019
Interaction SE	0	0.025	0.037	0.028	0.036	0.031
Nominal p-value	0.62	0.147	0.347	0.458	0.561	0.538
Corrected p-value	0.62	0.62	0.62	0.62	0.62	0.62
Test type	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed
Control mean	-0.024	0.009	-0.016	0.018	0.011	0.016
N	6675	6833	5780	5775	5797	5816

- Hk.1 (primary): T1 or T2 improves children's health and educational outcomes
  - Hk.1.i (secondary): T1 or T2 increases the proportion of children *without* diarrhea in the past week
  - Hk.1.ii (secondary): T1 or T2 increases the number of days that children are *not* absent from school
  - Hk.1.iii (secondary): T1 or T2 improves the proportion of children *not* being absent from school due to sickness
  - Hk.1.iv (secondary): T1 or T2 improves children's ranking in the most recent school test

```
## measures
# did any child have diarrhea at any time in the last 7 days [no is better; coded as 1]
```

[10]As above (footnotes 7 and 8), we may elect to analyze and discuss economic, educational, and cultural heterogeneity separately.

```r
  analysis_df$dv.c.diarrhea <- (mock_endline$e75=="b")*1

# how many days were children absent (on average) in school in last month!
  analysis_df$dv.c.daysabsent <-
    rowMeans(mock_endline[grep("e74_r7_", names(mock_endline))], na.rm = TRUE)

# any child absent from school due to sickness [no is better; coded as 1]
  analysis_df$dv.c.sickabsent <-
    rowMeans(mock_endline[grep("e74_r8_", names(mock_endline))]=="b", na.rm = TRUE)

# average of children's educational ranking [higher is better]
  mock_endline %<>%
    mutate_at(vars(starts_with("e74_r9_")), funs(
      case_when(
        .=="a" ~ 4,
        .=="b" ~ 3,
        .=="c" ~ 2,
        .=="d" ~ 1,
        .=="e" ~ 0)))
  analysis_df$dv.c.edurank <-
    rowMeans(mock_endline[grep("e74_r9_", names(mock_endline))], na.rm = TRUE)

# children's health/education index
  analysis_df <- make_index(vlist = c("dv.c.diarrhea",
                                      "dv.c.daysabsent",
                                      "dv.c.sickabsent",
                                      "dv.c.edurank"),
                            vname = "dv.c.healthedu.index")

## models
  ch1 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "upper") #[Hk.1]
  ch2 <- estimates(dv = "dv.c.diarrhea", treat = "t1ort2", pval = "upper") #[Hk.1.i]
  ch3 <- estimates(dv = "dv.c.daysabsent", treat = "t1ort2", pval = "upper") #[Hk.1.ii]
  ch4 <- estimates(dv = "dv.c.sickabsent", treat = "t1ort2", pval = "upper") #[Hk.1.iii]
  ch5 <- estimates(dv = "dv.c.edurank", treat = "t1ort2", pval = "upper") #[Hk.1.iv]

# p-value correction
  correct_p <- c("", round(p.adjust(as.numeric(as.character(
    c(ch2$mainp, ch3$mainp, ch4$mainp, ch5$mainp))), method = "fdr"), 3))

# make table
  mods <- c(ch1$tab, ch2$tab, ch3$tab, ch4$tab, ch5$tab)
  dvs <- c("dv.c.healthedu.index",
           "dv.c.diarrhea",
           "dv.c.daysabsent",
           "dv.c.sickabsent",
           "dv.c.edurank")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:				
	dv.c.healthedu.index	dv.c.diarrhea	dv.c.daysabsent	dv.c.sickabsent	dv.c.edurank
T1 Est.					
T1 SE					
T2 Est.					
T2 SE					
T1xT2 Est.					
T1xT2 SE					
T1orT2 Est.	0.006	-0.034	0.213	0.015	-0.042
T1orT2 SE	0.016	0.018	0.144	0.006	0.023
Interaction Est.					
Interaction SE					
Nominal p-value	0.359	0.966	0.076	0.01	0.958
Corrected p-value		0.966	0.152	0.04	0.966
Test type	upper	upper	upper	upper	upper
Control mean	-0.015	0.536	14.915	0.117	2.021
N	6869	5853	6869	6869	6869

- Hk.2 (secondary): The effect of T1 or T2 on children's health is more positive in households where children spend more time on water collection at baseline
- Hk.3 (secondary): The effect of T1 or T2 on children's health is more positive for less educated households
- Hk.4 (secondary): The effect of T1 or T2 on children's health is more positive for low-income households
- Hk.5 (secondary): The effect of T1 or T2 on children's health is more positive for SC/ST households
- Hk.6 (secondary): The effect of T1 or T2 on children's health is more positive for Muslim households
- Hk.7 (secondary): The effect of T1 or T2 on children's health is more positive for migrant households[11]

```
## measures
# children's time collecting water
  analysis_df$m.child.watertime <-
    rowMeans(mock_baseline[,c("b11_c", "b11_d")], na.rm = TRUE)

## models
  ch6 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.child.watertime", ex_cov = "cov_b11_fetchtime") #[Hk.2]
  ch7 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.no.primary", ex_cov = "cov_b97_literacy") #[Hk.3]
  ch8 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.low.income", ex_cov = "cov_b95_income") #[Hk.4]
  ch9 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.scst") #[Hk.5]
  ch10 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.muslim", ex_cov = "cov_b105_hindu") #[Hk.6]
  ch11 <- estimates(dv = "dv.c.healthedu.index", treat = "t1ort2", pval = "two-tailed",
                   mod_var = "m.migrant", ex_cov = "cov_b99_migrant") #[Hk.7]

# p-value correction
  correct_p <- c(round(p.adjust(as.numeric(as.character(
    c(ch6$mainp, ch7$mainp, ch8$mainp, ch9$mainp,
      ch10$mainp, ch11$mainp))), method = "fdr"), 3))
```

[11]As above (footnotes 7 and 8), we may elect to analyze and discuss economic, educational, and cultural heterogeneity separately.

```r
# make table
  mods <- c(ch6$tab, ch7$tab, ch8$tab, ch9$tab, ch10$tab, ch11$tab)
  dvs <- c(rep("dv.c.healthedu.index", 6))
  make_table(mods = mods, dvs = dvs, correct_p = correct_p, size = 5)
```

	Dependent variable:					
	dv.c.healthedu.index	dv.c.healthedu.index	dv.c.healthedu.index	dv.c.healthedu.index	dv.c.healthedu.index	dv.c.healthedu.index
T1 Est.						
T1 SE						
T2 Est.						
T2 SE						
T1xT2 Est.						
T1xT2 SE						
T1orT2 Est.	0.02	-0.001	0.002	-0.029	0.005	0.005
T1orT2 SE	0.047	0.02	0.025	0.023	0.019	0.032
Interaction Est.	0	0.019	-0.001	0.062	0.014	0.004
Interaction SE	0	0.032	0.036	0.032	0.077	0.043
Nominal p-value	0.763	0.559	0.974	0.067	0.857	0.93
Corrected p-value	0.974	0.974	0.974	0.402	0.974	0.974
Test type	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed	two-tailed
Control mean	-0.022	-0.011	-0.009	0.015	-0.02	-0.001
N	6710	6869	5810	5805	5826	5847

- Hk.8 (secondary): T1 or T2 improves the quality of drinking water consumed by households

```r
## measures
# water test quality (originally on 4-point scale)
  analysis_df$dv.water.quality <- (unclass(factor(mock_endline$e_water_quality))-1)/3

## models
  ch11 <- estimates(dv = "dv.water.quality", treat = "t1ort2", pval = "upper") #[Hk.8]

# p-value correction
  correct_p <- c("")

# make table
  mods <- c(ch11$tab)
  dvs <- c("dv.water.quality")
  make_table(mods = mods, dvs = dvs, correct_p = correct_p)
```

	Dependent variable:
	dv.water.quality
T1 Est.	
T1 SE	
T2 Est.	
T2 SE	
T1xT2 Est.	
T1xT2 SE	
T1orT2 Est.	-0.008
T1orT2 SE	0.013
Interaction Est.	
Interaction SE	
Nominal p-value	0.732
Corrected p-value	
Test type	upper
Control mean	0.503
N	6869

11 Attrition

Non-ignorable attrition will be diagnosed and (if present) addressed using the procedures laid out in "Standard Operating Procedures for Don Green's Lab at Columbia."[12]

12 Conclusion

Through the use of a novel field experiment in one of the world's largest cities, our study aims to contribute to our collective understanding of both the causes and consequences of formalization. In examining the causes of formalization, our study departs from the existing literature that focuses largely on state-side constraints to effective public service delivery. Instead, we examine the role of citizen-side constraints that impede the ability of citizens to access public services and sheds light on key ways in which these constraints could be alleviated. A main contribution of our study is to highlight the role of two important yet previously under-explored mechanisms pertaining to bureaucratic and electoral incentives that could potentially shape public service delivery.

In examining the consequences of formalization for political participation, we seek to shed new theoretical and empirical light on the avenues through which the political participation of poor and marginalized groups in society can be expanded and improved. The welfare of vulnerable sections of the population can often be further exacerbated if they do not participate in politics in a meaningful way. Conversely, when members of marginalized communities not only turn out to vote but also attend political rallies, assist in political campaigns, and acquire the political knowledge necessary to make meaningful political choices, these individuals can gain a greater voice in government decision-making—that can, in turn, enhance political and social equality. Thus, understanding the factors that lead individuals to strengthen and expand their participation in politics has important welfare consequences. Existing studies have uncovered several drivers of political participation, yet they have largely neglected to explore the role of formalization in mediating this process. By investigating whether and how citizens change their political attitudes and behavior as a result of formalization, we help close extant gaps in the literature

Our study also addresses the question of how citizens' attitudes toward, and engagement with, the state can be improved. Given the 'embedded' nature of many states in the developing world (Evans 1995), the effectiveness of states is typically not only a function of the intrinsic features of the state bureaucracy but also of the nature of the interactions between the bureaucracy, the citizenry, and elected politicians. Thus, understanding the key factors that improve the fiscal contract between citizens and the state is important for shaping our knowledge of how to improve state effectiveness. Our study seeks to test the argument that gaining formalized access to a specific service - water - should help to strengthen the fiscal contract between citizens and the state, which should lead to a boost in citizens' willingness to pay user fees for water, to pay taxes in other domains, and to approach the bureaucracy for access to other services. In examining how formalized access to public services shape citizens' attitudes and behaviors toward the state, our study seeks to shed new light on the mechanisms through which citizen-state interactions in the developing world could be improved.

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[12]The most current version of this document is available at https://github.com/acoppock/Green-Lab-SOP.

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