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Distortions in willingness-to-pay for public goods induced by endemic distrust in institutions

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ABSTRACT

In this paper, we analyze the implications for the economic valuation of the provision of public goods, considering respondents' perceptions of the institution(s) that provide the service. The specific behavioral mechanism whereby institutional distrust (ID) shows itself is through the activation of screening of choice options (choice set formation). However, ID-induced choice set formation might be confounded with the consumer budget constraint, especially in a developing country context, leading to biased welfare estimates for service improvement. We formulate a semi-compensatory hybrid choice set formation (SC-HCSF) model that enables us to 1) discriminate the effect of a budget constraint from that of ID-induced choice set formation and 2) characterize their separate impacts on welfare estimates using a spatial framework. We compare our model results to those from a standard Random Parameters Logit (RPL) Model. The RPL underestimates (overestimates) welfare when individuals have a low (high) ID. Based on our empirical model results, we demonstrate that the impacts of ignoring institutional trust issues can be highly deleterious to project appraisals, particularly in settings where legislative and regulatory institutions are perceived to be endemically corrupt.

1. Introduction

For a stated preference study to be considered valid, a set of assumptions needs to be fulfilled, salient among them is the issue of consequentiality (Carson and Groves, 2007; Vossler et al., 2012): that respondents are assumed to expect that their choice can affect the policy being investigated. More concretely, it often implies using setups with institutions that would also, in reality, carry out such policies. However, if these institutions are known to be prone to corruption, the elicited values (i.e., preferences, willingness to pay, elasticities) may be biased. This becomes increasingly important as stated preferences studies gain importance in developing country research and policy development. Analyzing the impact of consumer and citizen (dis)trust in institutions is a focal interest of the current paper in the context of improving electricity service (reducing power outages) in a developing country setting.

Institutional distrust (ID) has been largely ignored in the literature of non-market valuation involving stated preference (SP)[1] studies. Such distrust can lead to the perception that the likelihood of implementation of a described project is small. In the worst-case scenario, such distrust can become dysfunctional, the perceived negative expectations of the agents outweigh the benefits of the

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[1] The most widely used SP methods are contingent valuation (CV) and stated choice experiments (CE).

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activity, thus leading to the elimination of all value-creating opportunities (Tomlinson and Lewicki, 2006; Vedantam, 2014). In this circumstance, conducting and getting reliable information from SP studies is impossible. Individuals may not be willing to participate in the SP survey at all or provide a protest response. This issue can be identified during a focus group discussion/pre-test, and adjustments to the survey can be made accordingly as a standard approach to mitigate protest response in SP survey (Johnston et al., 2017; Kassahun et al., 2020a; Mariel et al., 2021; Meyerhoff and Liebe, 2010).[2] However, if a corrupt institutional structure is in place, it may be accepted in focus groups as realistic, and the result we obtain from such a study is just being adjusted for the unrecognized effects of ID. If a screening or elimination of alternatives (choice set formation) exists in the data generation process by the decision-maker arising from ID, yet goes unrecognized by the analyst, a bias in preference inferences and welfare estimates will occur (Li et al., 2015; Peters et al., 1995; Swait, 2001b; Swait and Ben-Akiva, 1987a; 1987b; Truong et al., 2015).

The objective of this article is to test whether such choice set formation processes based on ID takes place in a policy setting of provisioning a public good (reducing power outage) in Ethiopia. More specifically, we 1) formulate an (implicit) choice set formation econometric model that incorporates budget and institutional trust constraints within the framework of standard microeconomic choice theory; and 2) empirically demonstrate the importance of accounting for welfare estimate bias that dwells in the SP data when the ID effect goes unrecognized. A recent study supported by the World Bank and the government of Ethiopia showed that there is a perception amongst Ethiopian citizens that there is widespread corruption in their government in various sectors of the economy, including education, judicial, construction, and water provision and management (Plummer, 2012). This makes it interesting to conduct a case study in Ethiopia in the context of welfare estimation. Data collected from two regional capital cities in Ethiopia that differ in terms of political administration and ethnicity were used to estimate the marginal willingness to pay (WTP) for power outage reduction and watershed management attributes.

The remainder of this paper develops as follows: First, we review relevant literature on endemic institutional distrust and project evaluations; Second, we present theoretical and empirical model specifications; Third, we report and discuss empirical findings; Finally, we summarize findings and provide concluding remarks.

1.1. Literature

Institutional distrust (ID) can be conceptualized as an agent's negative expectations about institutional performance, likely based on learnings from observed past performance of that institution. This distrust is of substantive policy interest because its existence allows rational agents[3] to take protective action based on these expectations (Luhmann, 1979). This conceptualization is consistent with maximization of expected utility, and moreover, it allows an agent to have an individual-specific level of perceived ID based on their personal experiences and exposure. In this perspective, agents can engage in different levels of economic activity with parties and institutions to the degree that these interactions lead to (some measure of) positive outcomes (Ahlborg and Boräng, 2018; Dwyer and Bidwell, 2019; Murphy, 2006). However, beyond a certain level, distrust can become dysfunctional, i.e., the perceived negative expectations of the agent outweigh the benefits of the activity, leading to the elimination of all value-creating opportunities.

ID can arise due to widespread recognition of corruption among public officials. An illustration of this is the annual corruption index map produced by Transparency International.[4] Similarly, the World Bank reports various studies worldwide on the degree of real corruption and public money laundering. Although there may be a difference between perceived and actual corruption levels, the spatial patterns of such corruption are identical. The highest perceived and real corruption levels are recorded in developing countries. In Africa alone, about 25 percent of the GDP ($148 billion) is estimated lost every year because of corruption (World Bank, 2007, p. 9). Thus, the actual public or semi-public goods (i.e., private goods whose supply is controlled by the government) available to all agents are lower in terms of quality and quantity compared to an economy without corruption. However, for valuation of public goods, the actual level of corruption may not be as relevant and/or important as the level of corruption perceived by each agent; the latter is directly related to the perceived level of ID for providing goods and services.

Failure to account for ID may lead to erroneous conclusions about the importance of public projects and a rejection of socially desirable projects on the basis of cost-benefit analysis (Oh and Hong, 2012). For example, based on a review of 20 years of SP research in less-developed countries, Whittington (2010) concludes that willingness to pay is "*low, in both relative and absolute terms and in comparison to the costs of service provision*" (p. 209). However, none of the studies included in the review analyze the perceived uncertainty of the provision of public goods and services as a factor that can lower the expected utility of a project. Consequently, and

[2] There are various reasons an individual may show a protest response to the SP survey, including payment vehicle choice, the institute that administers funds, question format, intuitional distrust, among other factors (Johnston, et al., 2017; Kassahun, Jacobsen, et al., 2020; Mariel, et al., 2021; Meyerhoff & Liebe, 2010). For interested readers, Mariel, et al. (2021) provide an up to date coverage of literature about how to detect and treat protest responses. Potential factors that may lead to a protest response can be detected early during the focus group discussion and pre-tests. However, full eliminating an SP survey's protest response may not be possible even with careful design. Thus, a follow-up question to identify the reasons for the protest should be a routine procedure (Meyerhoff & Liebe, 2010). In the literature, there are two approaches regarding the treatment of protest response: 1) treating protest response as part of the modeling process and 2) removing protest response from the analysis. So far, there is no universal consensus on what action to take regarding protest responses literature (Mariel, et al., 2021). However, we advocate for the first approach because it is a conservative welfare estimate approach (Carson & Hanemann, 2005). We also believe that protest response is part of choice behavior and should be understood and analyzed.

[3] These are also sometimes termed economic agents or just agents. In the following we will suppress the first part and just call them agents. Whenever it refers to agents answering an empirical choice set we refer to them as respondents.

[4] https://www.transparency.org/.

considering the high level of ID arising from corruption in less-developed countries (Beekman et al., 2014; Olken and Pande, 2012; Svensson, 2005; Transparency-International, 2015), we argue that part of the explanation for low WTP may be related to the high level of intuitional distrust for implementing proposed projects. Distrust leads to the perception that the likelihood of implementation of a described project is small, or even zero, and hence projects may be excluded from the respondent's choice set. If we ignore the possibility that distrust leads to the elimination/screening of proposed projects from the (economic) agent's choice set, we will not correctly estimate the effect of screening by the agent's budget constraint. Our proposed model can, and does, discriminate the effect of the budget constraint and of ID; we are not aware of any other model that does so. The choice modeling literature presents choice set formation models that are either attribute or alternative based, and these will be reviewed in Section 2.

A second type of perceived institutional distrust, which is not the focus in this article, is a lack of confidence in the technical capacity of an institution. Globally, empirical evidence shows that agents' perception concerning the realism of project implementation might not be the same as presented in SP experiments (Birol and Das, 2012; Carson and Groves, 2007; Chen and Hua, 2015; Powe and Bateman, 2004; Speelman et al., 2010; Vossler et al., 2012; Yamamura, 2014). To illustrate, Powe and Bateman (2004) study a wetland conservation project in the UK. The authors report that agents perceive the likelihood of project implementation to be substantially lower for bigger projects, leading to scope insensitivity for willingness to pay (WTP) for wetland conservation projects. Similarly, Kassahun et al. (2016) report that about 83% of surveyed farmers in Ethiopia who refuse to pay for reliable access to irrigation water have a lower perceived expectation of future irrigation productivity than stated by domain experts. Thus, the predicted welfare change associated with quality distortions can arise due to the disparity between the quality presented in discrete choice experiments and the expected quality of the discrete public good.

2. The modeling framework

Despite the fact that microeconomic consumer theory explicitly allows for constraints on choice (specifically and most commonly, through income, though this need not be the only constraint considered), empirical choice studies almost universally assume that all alternatives in the universal choice set have some probability of being considered and chosen. Manski (1977) plays a central role in extending the idea of multiple constraints into models of choice by conceptualizing a two-stage choice process. He describes the probability π_i of choosing an alternative i as

$$\pi_i = \sum_{C \subseteq \Gamma} \pi(i|C)Q(C) \tag{1}$$

where $\pi(i|C)$ is the conditional probability of alternative i given the choice set C, Γ is the set of choice sets arising from the universal (or market) set with J alternatives, and $Q(C)$ is the probability that a respondent considers a specific choice set C.

The probability $Q(C)$can be expressed as a function of various factors (e.g., economic, temporal, physical, personal, and social constraints) that can lead to the inclusion or exclusion of an alternative from the choice set. Transport economists are generally considered to have pioneered the application of two-stage choice set formation models by developing several empirical model forms (Ben-Akiva and Boccara, 1995; Swait, 2001a; Swait and Ben-Akiva, 1987a, 1987b) reflecting the behavioral formulation in expression (1). However, empirical applications of these models can be challenging, since the cardinality of Γ is ($2^{|J|}$-1) sets, discounting the empty set as a member.

As a result, Swait (2001b) developed a non-compensatory choice set formation model by imposing stated attribute cut-off constraints in the utility specification, using the Lagrangian of the utility function as a paramorphic representation of a soft constraint decision process. This model form has a distinct advantage relative to earlier models of choice set formation: all alternatives are available for a given choice, eliminating the need for the enumeration of subsets of Γ, though some options might be subject to penalties due to constraint violations. Continuing the evolution of the concept that the agent might violate self-imposed constraints, this led to the development of what is termed an implicit or constrained multinomial logit model (MNL) (Martínez et al., 2009). Swait (2001b) and Martínez et al. (2009)'s models allow the agent to consider all alternatives in the universal set, but a utility penalty is imposed for alternatives that violate one or more endogenous attribute constraints and make them less attractive. For application examples of the constrained MNL, see Feo-Valero et al. (2016), Pérez et al. (2016) and Truong et al. (2015), and for comparison of two-stage and one-stage choice set formation models, see Bierlaire et al., 2010, Li et al. (2015) and Thiene et al. (2017). In this paper, using the framework of Martínez et al. (2009), we formulate attribute (e.g., price) and non-attribute (specifically, ID) based implicit choice set formation econometric model that incorporates budget and ID constraints within the framework of standard microeconomic choice theory. Detailed model development is presented in the following section.

2.1. Representing institutional distrust distortions on price and quality

The utility maximization framework under ID can be developed jointly from considerations about price and quality distortions for a discrete public good.[5] The term "distortion" is used to refer to a change in the perceived price or quality of a good that results from institutional distrust compared with an economy in which institutions are fully trusted by consumers. Let $p_1, \ldots, p_J$ be a set of prices for

[5] A discrete public good is characterized by attributes with a fixed quantity and quality levels, so that the individual cannot freely choose the amount of the good – it is non-rival and non-excludable.

the provision of discrete public good alternatives having given attributes. If the status quo alternative is chosen, the agent spends all her income (Y) on the purchase of a market good. Thus, the choice of any alternative other than the status quo results in lower consumption of the market good. To facilitate our discussion, we specify the indirect utility function as additively separable in budget share and attributes of the corresponding alternative. Accordingly, the utility of an alternative j for the nth agent is written from the analyst perspective assuming that agent has complete institutional trust for the provision of public good:

$$U_{nj} = -\alpha(p_j / Y_n) + \sum_{k=1}^{K} \beta_k^{'} X_{jk} + \varepsilon_{nj} \tag{2}$$

where α is a parameter to be estimated to a budget share (for now we assume a fixed parameter), $p/Y$is the expression of the budget share used for the public good, $\beta_k^{'}$are parameters to be estimated associated to attributes of the discrete public good, X, andε_{nj} is an unobserved stochastic component with zero mean which is independently, identically distributed (iid) over alternatives and agents.

Now assume that all agents are identical in every aspect except that they have a difference in the degree of perceived ID associated with managing public funds and providing public goods. The higher the distrust, the higher the perceived likelihood of public officials taking away public funds for their personal use, implying a requirement by the institution for more money than what is stated to offer the public good. This leads to an expectation of inflation in the price of the public good, and consequently, an expectation of deflation in the quality or quantities of attributes of the public good. Thus, an alternative chosen under perfect institutional trust conditions may not be preferred for an agent who is distrustful of the focal institution. Consequently, the price and the attributes of each alternative are agent-specific and (generally) unobserved from the econometrician's perspective. A convenient mathematical form of the price of the j^{th} alternative is

$$p_{nj}^{*} = p_j\left(1 + f\left(z_n^{*}\right)\right), \quad s.t.\, f\left(z_n^{*}\right) > 0 \tag{3}$$

where p_{nj}^{*} is the perceived price for the j^{th} alternative adjusted for the n^{th} agent's perceived ID, z_n^{*} is an unobservable factor (latent variable) representing the perceived ID. z_n^{*} can be defined using socio-demographic and spatial variables of the agent and $f(.)$is a functional form of ID .[6] Allowing for this individual specific ID means replacing p_j with the expression for p_{nj}^{*}(Equation (3)) in equation (2). This gives:

$$U_{nj} = -\alpha\left(\frac{p_j}{Y_n} + \frac{p_j f\left(z_n^{*}\right)}{Y_n}\right) + \sum_{k=1}^{K} \beta_k^{'} X_{jk} + \varepsilon_{nj} \quad s.t.\, f\left(z_n^{*}\right) > 0 \tag{4}$$

The utility specification in Equation (4) assumes the marginal utility of incomeα is constant. However, individual agents may give different weight for the part of the money used for the provision of a public good and the part of the money taken away by corrupt officials. The utility specification in Equation (4) can be modified to illustrate the marginal utility of income associated with provision of public good α and the marginal utility of income associated with perceived ID α^{*}:

$$U_{nj} = -\left(\alpha + \alpha^{*} f\left(z_n^{*}\right)\right)\frac{p_j}{Y_n} + \sum_{k=1}^{K} \beta_k^{'} X_{jk} + \varepsilon_{nj} \quad s.t.\, f\left(z_n^{*}\right) > 0 \tag{5}$$

Let p_j for the chosen alternative be the maximum price that the agent is willing to pay under full institutional trust, $p_j f(z_n^{*}) = 0$. Thus, if $p_j f(z_n^{*}) > 0$ (Equation (5)), the agent needs extra money to buy the good. That means the chosen alternative under complete institutional trust condition may not preferable for the agent because distrust inflates the price of the public good. However, if we assume that agents have some degree of price distortion tolerance θ, the likelihood of alternative rejection on the basis of ID is close to zero for all values such that $\theta \geq p_j f(z_n^{*}) > 0$. On the other hand, the likelihood of alternative elimination increase as $p_j f(z_n^{*})$ increases for all values $p_j f(z_n^{*}) > \theta$. Thus, $\theta/f(z_n^{*})$ sets the maximum price an agent willing to consider paying for a public good:

$$MaxPrice_{f(z_n^{*})} = \frac{\theta}{f\left(z_n^{*}\right)}, \quad s.t. \quad f\left(z_n^{*}\right) > 0 \tag{6}$$

Given the value of θ, the WTP for the public good declines as ID increases. Accordingly, we can specify the likelihood of consideration of alternatives,$\phi_{nj}(\bullet)$, on the bases of p_j and $\theta/f(z_n^{*})$, as a binary logit probability function (Equation (7)):

[6] The functional form of institutional distrust will be discussed in section 2.3. For consistency, we have used similar transformations of ID for both price and quality/quantity distortions.

$$\phi_{nj}(\bullet) = \left(1+\exp\left(p_j f\left(z_n^*\right)-\theta\right)\right)^{-1} = \left(1+\exp\left(f\left(z_n^*\right)\left(p_j-\frac{\theta}{f\left(z_n^*\right)}\right)\right)\right)^{-1} \quad s.t. \quad f\left(z_n^*\right)>0 \tag{7a}$$

Equation (7a) summarizes the discussion we have made above about price distortion tolerance. To accommodate the elimination of alternatives from the choice set in a utility specification we use the logarithm of $\phi_{nj}(\bullet)$ in the utility specification. The logarithm form is motivated as a convenient way of penalizing alternatives as the probability of consideration of the alternative is moving towards zero due to violation of θ or $\theta/f(z_n^*)$. An additional parameter may be specified as a penalty multiplier in the utility. Thus, the utility adjusted for price distortion tolerance penalty is:

$$U_{nj} = -\left(\alpha+\alpha^* f\left(z_n^*\right)\right)\frac{p_j}{Y_n}+\sum_{k=1}^{K}\beta_k^{'} X_{jk}+\lambda \log \phi_{nj}(\bullet)+\varepsilon_{nj} \tag{7b}$$

where λ is price distortion penalty multiplier.

2.2. Distortion in marginal WTP

Given the adjusted utility specification for price distortion in Equation (7b), the marginal WTP for an attribute is specified as the negative of the ratio between the partial derivative of attribute and price.

$$MWTP = -\frac{\partial U_{nj}/\partial X_{jk}}{\partial U_{nj}/\partial p_j} = -\frac{\partial U_{nj}/\partial X_{jk}}{-\left(\frac{\alpha+\alpha^* f\left(z_n^*\right)}{Y_n}\right)-\left(\lambda\frac{f\left(z_n^*\right)\exp\left(f\left(z_n^*\right)p_j-\theta\right)}{1+\exp\left(p_j f\left(z_n^*\right)-\theta\right)}\right)} = \frac{\partial U_{nj}/\partial X_{jk}}{\left(\frac{\alpha+\alpha^* f\left(z_n^*\right)}{Y_n}\right)+\left(\lambda f\left(z_n^*\right)\exp\left(f\left(z_n^*\right)p_j-\theta\right)\phi_{njb}(\bullet)\right)} \tag{8a}$$

From Equation (8a), the marginal utility of price (the denominator) can be decomposed into a preference effect arising from the price distortion due to ID and a choice set effect arising from the price utility penalty. As income increases, the preference effect of price decreases. Nevertheless, an increase in ID may offset the effect of an increase in income through the choice set effect. Consequently, this leads to a difference in welfare estimates depending on the level of ID. This will be illustrated subsequently in the result section through simulations and by comparison of empirical welfare estimates with and without ID effects.

The presence of heterogeneity in ID within the sample population will allow us to use cross-sectional data to estimate parameters and explore the impact of ID on welfare change (Equation (8a)). However, precaution is needed when dealing with sensitivity analyses of welfare change to ID.[7] First, note that ID is an attitude/perception formed over a long period. The change in long-held beliefs in society may take a long time. In this case, due to the inelastic nature of belief in a short time, measuring intra-individual welfare change due to ID is difficult without time-series data.[8] Thus, instead of conducting an unrealistic sensitivity analysis, welfare change can be explored through inter-individual differences. Second, suppose a group of individuals lives in the same geographical region and group members experience the exact same institutional setup. In this situation, individuals may have identical thoughts and expectations about the institute. Thus, the distortion in marginal WTP difference, $\triangle MWTP$, is given by assuming that regional institutions' performance for implementing public projects is different and hence, citizens' attitudes towards corruption and performance:

$$\triangle MWTP = MWTP^{r=1} - MWTP^{r=2} \tag{8b}$$

where r represents a geographical region, which will be included as an explanatory variable in defining z_n^*.

2.3. Standardized scale for institutional distrust

The theoretical model represented from Equation (3) to Equation (8) is developed based on price distortion effects arising from ID. In this section, we formulate the mathematical representation of ID and its measurement. Then, we provide a discussion on the need for a standardized scale for representing ID in the utility specification.

[7] This applies for any long-held belief and attitude.
[8] It is possible to do a sensitivity analysis. However, the sensitivity analysis may not be realistic.

Let the latent perceived ID z_n^* is defined as:

$$z_n^* = bS_n + \upsilon_n \tag{9}$$

where b is a vector of parameters to be estimated, S_n is a vector of observed explanatory variables of the agent, and υ_n is an unobserved stochastic component with zero mean and standard deviation σ. Since z_n^* is latent (unobservable) from the researcher's point of view, observed indicators of the latent variable of interest are used in a measurement model (for application example see Ben-Akiva et al. (1999); Hess and Beharry-Borg (2012); Kassahun et al. (2016); Vij and Walker, 2016;Thorhauge et al. 2020). Observed indicators are usually obtained in a survey by asking pertinent questions related to the focal construct of interest. If observed indicators for IDy_n, is categorical with an M point scale, the probability of observing $y_n = m, m = 1, 2, \ldots, M$can be modeled conditioning on the distribution of the latent variable z_n^* and the stochastic error, ξ_n. Assuming $\xi_n$is iid over agents, the conditional probability of the observed indicator for ID $\varphi(y_n = m|z_n^*)$ is given by:

$$\begin{aligned} \varphi(y_n = 1|z_n^*) &= \left(\frac{1}{1 + e^{y_n^*}}\right) \\ \varphi(y_n = 2|z_n^*) &= \left(\frac{1}{1 + e^{y_n^* - \tau_2}}\right) - \left(\frac{1}{1 + e^{y_n^*}}\right) \\ &\vdots \\ \varphi(y_n = M|z_n^*) &= 1 - \left(\frac{1}{1 + e^{y_n^* - \tau_{m-1}}}\right) \end{aligned} \tag{10}$$

where

$$y_n^* = d + \gamma z_n^* + \xi_n \tag{11}$$

d and γ are a constant and factor loading to be estimated, and τ is a vector of threshold values to be estimated (M-2 threshold value are identifiable). A significant parameter estimate of γ is required as a measure of reliability and validity. The sign of γ is also crucial to inform the direction of the latent variable for interpretation.

Note that the perceived ID definition in Equation (9) allows z_n^* to have unrestricted value on the real number line. This unrestricted sign creates a problem for direct use of z_n^* for our theoretical model development as well as welfare estimation (Section 2.2). Therefore, throughout our model development, ID is represented as a functional form of perceived ID as$f(z_n^*) > 0$. We use the logistic transformation of z_n^* in Equation (12) to circumvent this problem, standardizing the representation of ID within the interval [0,1]:

$$f(z_n^*) = \frac{1}{1 + \exp(-z_n^*)} \tag{12}$$

Thus, Equation (12) can be considered as an ID index ranging between 0 and 1. Estimation issues and model identification will be discussed in section 3.3.

3. Empirical application

The data for this study were obtained from a discrete choice experiment survey in Ethiopia as part of the Forest and Nature for Society (FONASO)[9] project entitled Stated Preference Studies for Valuing the Environment in Developing Countries. The FONASO project was carried out under the objective of linking ecosystem service providers (land users, Kassahun and Jacobsen (2015)), service users in the context of irrigation (beneficiary farmers, Kassahun et al. (2016)) and hydropower service (electricity connected citizens). This paper focuses on part of the project that investigates citizen's WTP for power outage reduction and watershed management through the choice experiment method. Morrissey et al. (2018) has provided an overview of the use of choice experiment for valuing reliable electricity supply both in developed and developing countries. For detail treatment of power outages and its implication in a developing country context see, Zemo et al. (2019). The current study contributes to the literature on the value of power outage reduction measurement (Abdullah and Mariel, 2010; Blass et al., 2010; Carlsson and Martinsson, 2008; Hensher et al., 2014; Morrissey et al., 2018; Sagebiel and Rommel, 2014; Zemo et al., 2019) in the presence of institutional distrust (ID) in Ethiopia.

The electricity sector in Ethiopia, which is almost entirely dependent on hydropower (Gabreyohannes, 2010; Zemo et al., 2019), is characterized by frequent power outages. The average power outage is 44.2 days per year, which is higher than the average power outage for low-income countries (Foster and Morella, 2011). Power outage in Ethiopia is largely associated with reduced water levels in hydropower reservoirs due to reservoir siltation and fluctuating rainfall (Awulachew et al., 2008; Gabreyohannes, 2010; Wolancho, 2012). Thus, to solve the power outage problem and to satisfy the growing demand for electricity, the government of Ethiopia, as a sole producer and supplier of electricity, has launched a large-scale hydropower project, the Grand Ethiopian Renaissance Dam, on the Blue

[9] http://fonaso.eu/projekter/2011-2014/.

Nile River. The construction of a huge hydropower plant does not per se produce a reliable electricity supply: historically, soil erosion and debris from the highlands of Ethiopia have made hydropower production difficult on reservoirs constructed along the Nile River (Awulachew et al., 2008; Bashar et al., 2010). Thus, the choice experiment design in this study targets both the power outage reduction and watershed management components to assess electricity connected agents' WTP for each of the attributes (Section 3.3.1).

The survey was carried out between October and December 2012 in the cities of Bahir Dare and Mekelle; the former is the national regional state capital city of the Amhara, and the latter of the Tigray Regional States. Bahir Dar is located at the heart of the Blue Nile Basin, very close to erosion hot spots of the Blue Nile Basin where the proposed watershed management plan is to be implemented (Awulachew et al., 2008). Mekelle is located outside the Blue Nile Watershed and is the most populous regional capital city of Ethiopia. They both receive power from hydropower plant. The two regional capital cities have different administrative and ethnic backgrounds. In addition to this, these two ethnic group have historically been political rivals in Ethiopian politics. Since 1991 political power has been dominated by the Tigray Liberation Front (for detail on this topic, see Appendix 1). Thus, besides the discrete choice experiment, the survey design includes several questions related to ethnic background, socio-demographic, attitudinal, and perceptual questions to test the impact of ID.

3.1. *Attributes and the choice experiment design*

We have selected six attributes and their levels from a pertinent literature review, focus group discussions with users of electricity, experts and two pre-tests (30 individuals per pre-test using face to face interview). The attributes of the choice experiments are presented in Table 1[10]. The power outage attribute is a nested attribute, which encompasses peak and off-peak power outages. If both peak and off-peak hours appear (i.e. peak = 1 & off-peak = 1) in an alternative, the power outages are shared equally between peak and off-peaks, otherwise, the full power outage occurs for one of them. Under watershed management, we have two attributes that target reservoir siltation reduction: Area covered by integrated soil conservation and afforestation measure (SCA) and free grazing area converted to cut and carry livestock management system (CCS). Respondents, assumed to act as economic agents, were informed that watershed management activity is performed by farmers (owners of the land who live in erosion hot-spot areas of Amhara and Oromia regional states of Ethiopia) in order to reduce reservoir sedimentation, and consequently, affect the power generation capacity of hydropower plants. Moreover, implementing appropriate watershed management measures requires farmers' collaboration, financial incentives for farmers as well as government institutions monitoring and evaluating implemented soil conservation projects (Kassahun and Jacobsen, 2015; Kassahun et al., 2020). All respondents who are connected to the electricity distribution system are required to contribute financially if the project is implemented. For this, an additional monthly payment is proposed through the electricity bill.

The choice sets were generated using a fractional factorial design optimized for D-efficiency for a multinomial logit model. The design was grouped into four blocks of nine tasks, for a total of 36 tasks; respondents were randomly assigned to blocks and were sequentially exposed to the corresponding nine tasks. Each choice card has two policy alternatives and one status quo option (Appendix 3).

3.2. *Sampling, descriptive statistics and the institutional distrust measurement*

A total sample of 560 respondents, distributed evenly between the two cities, was selected through three-stage (stratified) random sampling, which first selected 11 out of 38 Kebeles (districts), then in each 1 or 2 sub-districts were randomly selected, and finally, 35 respondents were randomly selected from each of these. The complete up-to-date list of residents for each sub-districts was obtained from the local police station.

The descriptive statistics of socio-economic characteristics and stated ID from respondents in the two cities are presented together in Table 2. There are some differences in the sample composition of respondents in educational and work status between the two regions. In particular, tertiary education level, the share of government-employed and self-employed differs between regions. Per capita income is slightly higher in Mekelle. We have also created an additional variable, Young, from respondent's age, to reflect the political structural change in Ethiopia: 1 if the respondent was less than 18 years when the current ruling party of the country took power in 1991, otherwise 0.

The descriptive statistics present in Table 2 for ID indicators (IDI) are generated from the responses on the following two beliefs using a 5 level agree/disagree scale.

IDI 1: I believe that the existing institutional structure is capable of implementing both the conservation and power reduction plan.
IDI 2: I believe that the money collected for power outage reduction program is only used to finance the watershed conservation.

To select these indicators from among 6 available, we conducted a factor analysis with one factor. The factor loadings are 0.81 and 0.79 for IDI 1 and IDI 2 respectively. The share of individuals who have answered "totally agree" and "somewhat agree" for both indicators is more than twice as large in Bahir Dar as in Mekelle (Table 2).

[10] In the final survey, before the choice experiment (CE) was initiated and the attributes and attribute levels were defined, the respondents were informed about the relationship between hydropower production and watershed management in the CE scenario. The translated wording of the CE scenario is presented in Appendix 2.

Table 1
Attributes and attribute levels used in the choice experiment.

Attributes	Attribute Levels	Status quo
Power Outage (hours/week)	0, 3.5, 7, 10.5, 14, 17.5 and 21	21 h
Peak	No = 0, Yes = 1	1
Off-Peak	No = 0, Yes = 1	0
Watershed Management ('000' of hectare)		
Area covered by integrated soil conservation and afforestation measure (SCA)	75, 150 225, 300, 375 and 450	0
Free grazing area converted to cut and carry system (CCS)	6, 12, 18,24, 30, and 36	0
Additional monthly payment through the electricity bill (ETB/Month)	0, 22, 44, 66, 88, 110	0

Table 2
Descriptive statistics and descriptive statistics of socio-economic characteristics and stated ID.

	Amhara Bahir Dar (N = 280)	Tigray Mekelle (N = 280)	Joint Sample (N = 560)
No education (NO_EDU)	0.13	0.17	0.15
Elementary education (EL_EDU)	0.14	0.21	0.17
High school (HS_EDU)	0.16	0.15	0.15
University preparatory class or two years college (UP2YC)	0.37	0.23	0.30
DEGREE	0.20	0.25	0.22
UNEMPLOYED	0.16	0.15	0.15
Self-employed (SEMPLOYED)	0.40	0.55	0.47
Government employed (GEMPLOYED)	0.33	0.19	0.26
Private company employed (PEMPLOYED)	0.06	0.08	0.07
RETIRED	0.05	0.03	0.04
Young (1 if age < 18 in 1991)	0.49	0.63	0.56
Per capita income (PCI in "000" per month)	0.94 (1.49)	1.03 (1.16)	0.98 (1.34)
Institutional Distrust Indicator (IDI) 1			
1 : Totally agree	0.14	0.33	0.23
2 : Somewhat agree	0.22	0.35	0.29
3 : Uncertain	0.39	0.19	0.29
4 : Somewhat disagree	0.09	0.08	0.09
5 : Totally disagree	0.15	0.041	0.09
Institutional Distrust Indicator (IDI) 2			
1 : Totally agree	0.08	0.30	0.19
2 : Somewhat agree	0.18	0.27	0.22
3 : Uncertain	0.48	0.30	0.39
4 : Somewhat disagree	0.13	0.09	0.11
5 : Totally disagree	0.13	0.05	0.09

3.3. Empirical model specification, model identification and estimation

In section 2.2 we have established the theoretical model framework of a semi-compensatory hybrid choice model to account for ID-induced price and quality distortions. Now we present the empirical model specification and discuss model identification issues, which will be followed by a discussion about model estimation. The empirical model has four main components: the structural model that explains perceived ID, the measurement model for institutional distrust indicators, the structural model that explains utility with penalty associated for price and quality distortions, and the measurement model that explains choice.

3.3.1. Structural and measurement models for perceived institutional distrust

We assume that the perceived ID (Equation (9)) to be a function of Ethnicity (Amhara), Young, Work status, Education Level and Male. There is evidence for the existence of a strong link between ethnicity and institutional trust (Kimenyi, 2006; Whitt, 2010), in the Ethiopian context. In our model, specification of education levels, university preparatory class or two years college is used as a reference group. The literature has not conclusively shown an effect of education on distrust of government (Christensen and Lægreid, 2005). Educated people may have knowledge of administrative government, and may know how these systems work in the delivery of public goods and services. Therefore, depending on their knowledge and analytical capacity they may trust or distrust the government. Among the work status category (Table 2), self-employed and private company employed people are expected to explain some measure of ID. Accordingly, including sigma (σ), 10 parameters will be estimated for the latent variable ID (Equation (9)).

The measurement equation for the perceived ID is already defined in Equation (10). The two ID indicators that are defined in 3.2 is used to estimate the factor loading and threshold values.

3.3.2. Structural model for utility

The utility specification adjusted for ID in Equation (7) is based on cross-sectional data. However, respondents in a choice experiment often perform repeated choices. This repeated choice situation may create a correlation among alternatives across tasks between experimentally designed policy attributes. Thus, an additional error parameter is often specified to capture the joint movement of policy alternatives together with alternative specific constant correspondent to policy alternatives (ASC = 1 if policy alternatives, = 0 if status-quo). The utility of choosing alternative i at task t is given by:

$$U_{nit} = -\left(\alpha + \alpha^* f\left(z_n^*\right)\right)\frac{p_{it}}{Y_n} + \sum_{k=1}^{K} \beta_k' X_{jk} + ASC + \lambda \log \phi_{nit}(\bullet) + \eta_n + \varepsilon_{nit} \tag{13}$$

where η_n is a joint normally distributed component for experimentally designed policy alternatives with zero mean and standard deviation ρ. Let V_{nit} represents systematic component of utility:

$$V_{nit} = -\left(\alpha + \alpha^* f\left(z_n^*\right)\right)\frac{p_{it}}{Y_n} + \sum_{k=1}^{K} \beta_k X_{jk} + ASC \tag{14}$$

Then, Equation (17) can be written as:

$$U_{nit} = V_{nit} + \lambda \log \phi_{nit}(\bullet) + \eta_n + \varepsilon_{nit} \tag{15}$$

Another important consideration about the utility specification is that the combination of data from different regions may require adjustment of the scale (variance) of the data for meaningful comparison of results (Swait and Louviere, 1993). In this application, we've argued that the two cities have many reasons to display differences, from both systematic and stochastic sources. Hence, to account for potential stochastic differences arising from different distributions of ε in the two cities, we have specified a regional scale parameterμ, by allowing the estimation of scale parameter for Amhara and fixing the scale parameter for Tigray to 1 for identification purposes.

3.3.3. Measurement model for choice

Given the empirical utility specification in Equation (15), the measurement model for the observed choice indicator (δ_{int}) can be expressed as:

$$\delta_{\text{int}} = \begin{cases} 1, & if\ U_{nit} = \max_{j \in C_{nt}} \{U_{jnt}\} \\ 0, & otherwise \end{cases} \tag{16}$$

where C_{nt} is the set of alternatives presented to n at choice task t. Assuming $\varepsilon_{nit}$is iid over alternatives, and task, and conditioning on β, z^* and η, the choice probability of the sequence of choice is given by the mixed logit panel probability function (Train, 2009; Train et al., 1987):

$$\pi(\beta, z^*, \eta) = \prod_{t=1}^{T} \frac{\exp(\mu(V_{ni^*t} + \lambda \log \phi_{ni^*t}(\bullet) + \eta_n))}{\sum_{j \in C_{nt}} \exp\left(\mu\left(V_{njt} + \lambda \log \phi_{njt}(\bullet) + \eta_n\right)\right)} \tag{17}$$

where $\pi(\beta, z^*, \eta)$ is the conditional probability of choice for fixed z^* and η, i^* is the chosen alternative. The unconditional choice probability, $\pi(\delta)$, is obtained by integrating over the random variables β z^* and η:

$$\pi(\delta) = \iiint \pi(\beta, z^*, \eta) f(\beta) f_1(z^*|S_n, \upsilon_n) f_2(\eta) d\beta dz^* d\eta \tag{18}$$

where $f(\beta)$,$f_1(z^*|S_n, \upsilon_n)$ and $f_2(\eta)$ are the densities of random parameters, perceived ID and of η, respectively. We refer to Equation (18) as semi-compensatory choice set formation (SC-CSF) probability model.

3.3.4. Estimation

So far we have discussed the specification of each of the empirical model components. One final consideration for the joint estimation of choice and ID indicators (Equation (19)) is related to the identification of the error variance in the latent ID model: either the error variance or one of the regression parameters must be normalized. For detail on this matter see Vij and Walker, 2014. In this paper, given that we have only two indicators for ID, we take an alternative approach for normalization. We are able to estimate all parameters related to ID by normalizing the effect of the latent variable on the two ID indicator to be the same. Thus, the unconditional probability of observing the joint sequence of choice and observed indicators (m = 1,2) for ID for person n is:

$$\pi(\delta, y_{nm}) = \iiint \pi(\beta, z^*, \eta)\varphi(y_{n1}|z_n^*)\varphi(y_{n2}|z_n^*)f(\beta)f_1(z^*|S_n, \upsilon_n)f_2(\eta)d\beta dz^* d\eta \tag{19}$$

Since Equation (19) does not have a closed form, the probability is approximated through simulated maximum likelihood estimation procedure (details in Train 2009).[11] The sample log likelihood is given by:

$$LL = \sum_{n=1}^{N} \log \pi(\delta, y_{nm}) \tag{20}$$

3.4. Comparing model fit and welfare measures across models

To benchmark the performance of our semi-compensatory hybrid choice set formation (SC-HCSF) probability model (Equation (20)) that incorporates budget and ID constraints, we estimate a standard random parameter logit (RPL) model assuming a lognormal distribution for the price parameter.[12] We know that the RPL can approximate the choice probability of any discrete choice model and can serve as a baseline model for comparison (McFadden and Train, 2000). Like the RPL model, our proposed model allows the marginal utility of price/income to be randomly distributed over the sampled population. However, our model distinguishes the source of heterogeneity as both preference and choice set effects separately; conceptually, this is the only difference between our proposed model and the RPL model. We will gauge the impact of this specification difference by how well the proposed model fits and predicts out of sample data, and whether the new specification proposed in this article provides different policy insights in terms of welfare estimation compared to RPL.

Note that the likelihood function in Equation (20) is composed of the SC-CSF probability model (Equation (18)) and indicators of ID (Equation (10)). For model compression purpose, we need to separate the SC-CSF probability model from the indicators of ID models. Once the SC-HCSF probability model is estimated (Equation (20)), the choice probability for the SC-CSF model (Equation (18)) is obtained using estimated parameters and can be used directly to test model performance (Likelihood Ratio Test, LRT, and Akaike information criterion, AIC) and out of sample predictions with other standard choice models. We will use the Pearson's chi-Squared ratio for assessment of model prediction performance on 10% of the sample which we set aside as a holdout. The Pearson's chi-Squared ratio is given by (Swait et al., 1994):

$$\Pr = \sum_{j=1}^{R}\left(\frac{\delta_{int} - \widehat{\delta}_{int}}{\sqrt{\widehat{\delta}_{int}\left(1 - \widehat{\delta}_{int}\right)}}\right)^2 \Bigg/ (R - N - K) \tag{21}$$

where Pr is the Pearson's chi-Squared ratio. $\widehat{\delta}_{int}$ is the predicted probability of an alternative for an individual at time t. R is the sum of all alternatives from all choice sets N. K is the number of parameters estimated in the model.

4. Results and discussions

The results of the estimated models for the RPL and SC-HCSF models are presented in Table 3. For simplicity, in Table 3 we have partitioned model results into three parts: 1) Parameter estimates of the latent ID model, 2) parameter estimates of the ordered logit latent variable indicator model and 3) Parameter estimates of the choice model. Except for the price parameters, the distributional assumption for parameters of the choice models are the same in the two models.[13] For both the Peak and Off-Peak power outage attributes, we use the negative of the lognormal distribution, and for the parameters of watershed management attributes, we employ the normal distribution. Different from the RPL model which has only the structural model of the utility and measurement model for the choice, the SC-HCSF model has four main components: the structural model that explains perceived institutional distrust (ID), the measurement model for institutional distrust indicators (IDI), the structural model that explains utility with penalty, and measurement model that explains choice. The model statistics presented for SC-HCSF section reflects only the part of SC-CSF probability model as noted in section 3.4. The SC-CSF is better in terms of LRT and AIC compared to RPL model, and it is superior in terms of out of sample

[11] we use in Python Biogeme (Bierlaire, 2003) to estimate the model.

[12] $LL_{RPL} = \sum_{n=1}^{N} \int \log \prod_{t=1}^{T} \left(\frac{e^{\beta' X_{nit}}}{\sum_j e^{\beta' X_{njt}}}\right) f(\beta) d\beta$, where: LL_{RPL} is log likelihood for RPL, X_{njt} are the observed variables listed in Table 1, β_n' is a vector of coefficients of the variables for respondent n representing the his/her tastes, random parameters.

[13] We determined the distribution type based on the attributes' nature(Revelt and Train, 1998). For variables where all individuals are expected to have the same sign, we use lognormal distribution. For example, we anticipate that everybody dislikes power outage. Thus, the negative of lognormal distribution applied for both peak and off-peak hour power outage. We use the normal distribution for variables for which individuals are anticipated to have either positive or negative preference.

Table 3
Model estimates: Random Parameter Logit (RPL) model, and a Semi-Compensatory Hybrid Choice Set Formation (SC-HCSF) Model.

	RPL			SC-HCSF		
A. Parameter estimates for latent variable models						
Name	Value	*t*-test	p-value	Value	*t*-test	p-value
Amhara				1.570	4.06	0.00
Young Amhara				−0.910	−2.40	0.02
Male				−0.637	−1.22	0.22
Illiterate				−0.728	−2.95	0.00
Elementary				−1.220	−1.44	0.15
High School				0.035	0.04	0.97
University Degree				−1.180	−2.48	0.01
Private company Employed				−1.120	−1.66	0.10
Self-Employed				−1.610	−2.82	0.00
Sigma				4.230	9.33	0.00
B. Parameter estimates for the ordered logit latent variable indicator models						
	RPL			SC-HCSF		
Name	Value	*t*-test	p-value	Value	*t*-test	p-value
IND1						
$\Upsilon 1$				0.113	3.52	0.00
d1				1.410	10.08	0.00
$\tau 11$						
$\tau 12$				1.390	13.05	0.00
$\tau 13$				2.940	18.23	0.00
$\tau 14$				3.740	19.29	0.00
IND2						
$\Upsilon 2$				0.113	3.52	0.00
d2				1.720	11.66	0.00
$\tau 21$						
$\tau 22$				1.230	11.47	0.00
$\tau 23$				3.180	18.69	0.00
$\tau 24$				4.090	20.67	0.00
C. Parameter estimates of choice model						
	RPL			SC-HCSF		
Name	Value	*t*-test	p-value	Value	*t*-test	p-value
Amhara Scale	1.150	7.12	0.00	0.905	6.49	0.00
Tigray Scale	1			1		
ln price (−)	−4.360	−30.36	0.00	−23.800	−22.91	0.00
ln price sd (−)	−2.190	−11.92	0.00			
ln price ID (−)				−2.090	−8.84	0.00
Power outage						
ln Peak (−)	−2.410	−19.00	0.00	−2.380	−17.97	0.00
ln Peak sd (−)	−0.713	−6.70	0.00	−0.809	−5.20	0.00
ln Off-Peak (−)	−3.690	−12.80	0.00	−3.520	−13.13	0.00
ln Off-peak sd (−)	−1.300	−6.34	0.00	−1.230	−6.87	0.00
Watershed Management						
SCA	0.034	7.05	0.00	0.034	6.57	0.00
SCA sd	0.023	1.41	0.16	−0.030	−3.15	0.00
CCS	0.114	4.27	0.00	0.130	4.25	0.00
CCS sd	−0.133	−1.93	0.05	−0.152	−2.42	0.02
Price distrust penalty						
ln Penalty multiplier, λ				0.111	3.13	0.00
Price Distortion tolerance, θ				32.800	7.06	0.00
ASC Policy	12.200	5.50	0.00	10.300	5.18	0.00
ASC Policy sd	11.200	5.87	0.00	10.100	5.66	0.00

Model statistics (Continued from Table 3)

	RPL	SC-CSF of SC-HCSF
No. of draws (MLHS):	2000	2000
Sample size	4 527	4 527
No. of individuals	503	503
No. parameters (choice)	13	25
Final log likelihood	−1708	−1 686
Likelihood Ratio Test (LRT)		44.600
Prob > chi 2 (12 degrees of freedom)		0.001
AIC (−2.0 × LL+2 × k)	3 442.56	3 421.96

(*continued on next page*)

Table 3 (*continued*)

Model statistics (Continued from Table 3)		
	RPL	SC-CSF of SC-HCSF
Out of sample prediction		
No. of draws (MLHS):	2000	2000
Sample size	503	503
No. of individuals	57	57
Log likelihood	−420	−184
Pearson's chi-Squared ratio	0.948	0.898

d and Υ are constants and factor loadings respectively. Note that the factor loading s ($\Upsilon 1$ and $\Upsilon 2$) are constrained to be the same for identification purpose. τs are ordered logit cut-off parameters. $\tau 11$ and $\tau 21$ are fixed to 0, for that we able to estimate the two constants (d1 and d2).
SCA- Area covered by integrated soil conservation and afforestation measure.
PCI- Per capita income.
ID – Institutional distrust.
CCS - Free grazing area converted to cut and carry system.
Note that **sd** is not the standard deviation (it can be positive or negative). The variance is $(\mathbf{sd})^2$.
t-statistics is based on robust standard error.

prediction with a Pearson's chi-squared ratio value of 0.898 compared to 0.948 for the RPL model.[14] In terms of parameter estimates, the two models have almost the same magnitude and sign for both power outage and watershed management attributes. Thus, any difference accounted in welfare estimate between the two models is necessarily related to the specification of the budget constraint. Accordingly, we first focus on the results of SC-HCSF, and then we will discuss the RPL model in comparison with SC-CSF.

4.1. Parameter estimates of the latent institutional distrust model

Out of 10 variables (including the random error term) that are specified to explain the latent ID model (Table 3 panel A), six variables are significant at least at 0.05 significant level. Self-employed respondents have lower ID compared to government employed, unemployed and retired people. Respondents with a university education also demonstrate lower ID. Among the significant variables, ethnic origin takes an important position in explaining ID: respondents with Amhara ethnic origin have a higher ID compared to those from Tigray. This can be easily noticed from the box plot generated from the fitted value of parameters of the latent ID between the two regions in Fig. 1. The average ID for Amhara, Tigray and total sample are 0.42, 0.11 and 0.26, respectively. The difference in ID between the two regions is statistically significant at 99.9% confidence interval.

The disparity in ID between the respondents from Amhara and Tigray (Fig. 1) may be related to the difference in the perceived corruption and actual performance of regional and central governments when implementing regional public projects and citizens' attitude towards corruption and performance. Both the regional and the central governments are heavily involved in the implementation of different public goods projects, which gives citizens opportunities to develop attitudes and perceptions of the performance of government regarding public projects (Plummer, 2012). Moreover, as we have noted in Appendix 1, the political party administering the Amhara region, the Amhara National Democratic Movement (ANDM), was created by the Tigrayan People's Liberation Front (TPLF) after overthrowing the military government in 1991; thus, the people of Amhara may not consider the regional government a legitimate representative of their interests.

4.2. Parameter estimates of the ordered logit latent variable indicator model

The measurement model of the latent variable model can be considered a measure of reliability and validity in addition to a preliminary test of factor analysis. The results from the two ordered logit indicators models are presented in Table 3B. The parameters are highly significant with their expected signs and confirm construct validity.

4.3. Parameter estimates of the choice models

The parameter estimates of the SC-HCSF choice and the RPL models are presented in Table 3C. The models provide the same conclusion regarding preference magnitude, sign and significant levels for power outage and watershed management attributes with minor differences. Respondents dislike both peak and off-peak power outages. As expected, the exponentiated magnitude of the disutility is higher for peak power outage compared to off-peak power outages. The parameters of watershed management attributes, area covered by integrated soil conservation and afforestation measure (SCA) and free grazing area converted to cut and carry system (CCS) are significant and positive. The choice model used in the estimate is using an error component. The error component (standard deviation of ASC) captures a fixed error across the same respondent's repeated choices for the policy alternatives. It is highly

[14] Vij and Walker (2016) reported that the addition of a latent variable in a hybrid choice model enables us to understand choice decisions better than an alternative model specification such as RPL. They noted that the use of a hybrid choice framework does not improve model performance. Thus, the only explanation for better model performance is the addition of the choice set component in our utility specification.

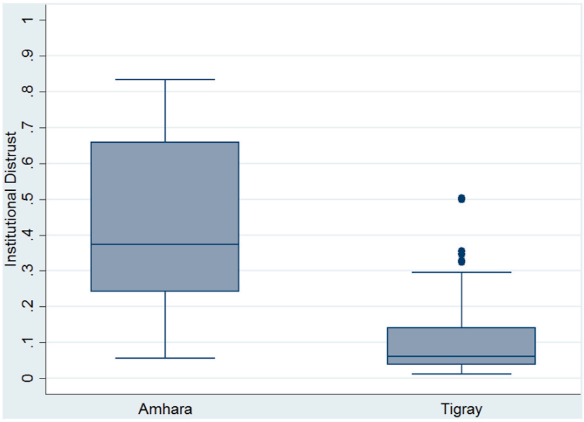

Fig. 1. Box plot of Institutional Distrust (Equation (12)) for Amhara and Tigray.

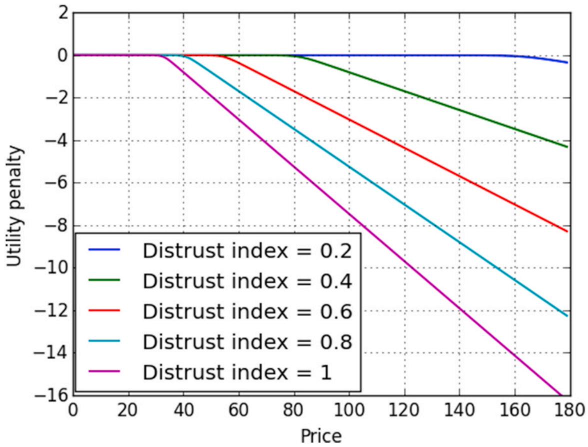

Fig. 2. Simulated utility penalty, $\lambda \log \phi_{nj}(\bullet)$, for price distortion for various levels of ID.

significant. In the RPL, the scale parameter for Amhara (μ_{Amhara}) is not significantly different from 1, which is the level at which the scale for Tigray is fixed for identification; so this model is indicating that the utility error distributions are the same for both cities.

In the SC-CFM model, the price effect can be decomposed into direct utility (αin the utility function, and α^* in the ID model) and a choice set effect through the price distrust penalty, i.e., price distortion penalty multiplier, λ, and a budget-share distrust constraint cut-off, θ (Equation (7)). Given the magnitude of the parameter estimates of α, we can conclude that the direct price effect is almost zero, -exp (α). Using parameter estimates of λ and price distortion tolerance, θ, we demonstrate the effect of price and ID on utility penalty, i.e. $\lambda \log \phi_{nj}(\bullet)$ in Fig. 2. As with the RPL model, the SC-CFM indicates that the two cities have equal scales since the Amhara scale is not significantly different from unity.

Fig. 2 shows that for any value of price, the utility penalty, $\lambda \log \phi_{nj}(\bullet)$, is close to zero for an ID index value close to zero (Equation (12)). Thus, the actual price range presented in the choice experiment has a negligible effect on utility compared to the level of ID. Price distortion increases as the level of ID increases as the maximum price to pay for the alternative under consideration declines at the rate of $\theta/f(z_n^*)$ (Equation (6)) — and that is where the penalty starts functioning for each level of ID in Fig. 2. At full distrust, the prices distortion tolerance is equals to θ,.i.e., 32.8 Ethiopian Birr (ETB), meaning that any price increase beyond 32.8 leads to a utility penalty.

Moreover, by looking at the values of the marginal utility of price, ,$\partial U/\partial p$[15] with the corresponding value of ID for of Amhara (0.42) and Tigray (0.11) (Fig. 3A) for a range of income, we can see the absolute marginal utility of price is higher for Amhara, consequently

[15] Denominator of Equation 8a.

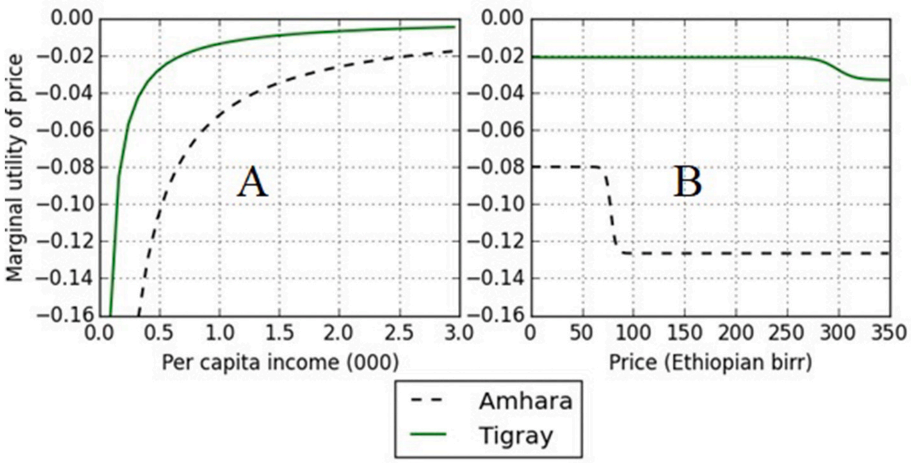

Fig. 3. Marginal utility (MU) with respect to price ($\partial U/\partial p$) evaluated at average institutional distrust value of Amhara (0.42) and Tigray (0.11).

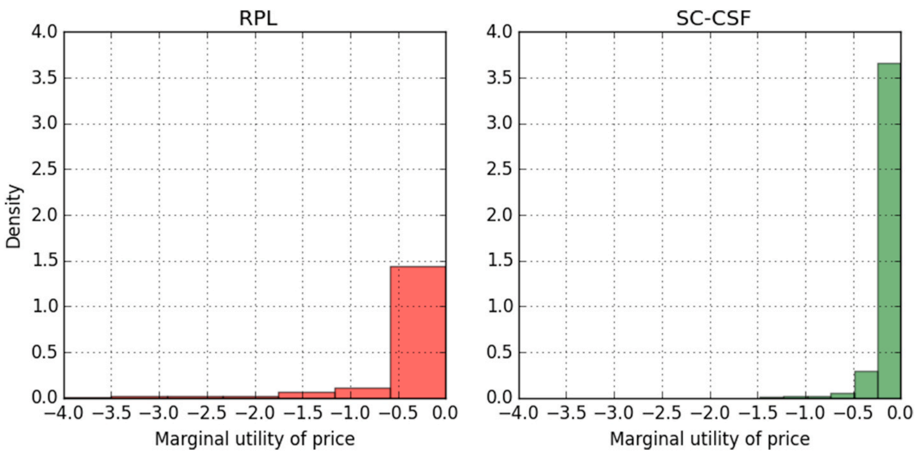

Fig. 4. Density of marginal utility of price for RPL and SC-CSF.

Table 4
Marginal WTP for power outage reduction and watershed management attributes for sample (N = 503), Amhara (N = 245) and Tigray (N = 258).

	RPL			CS-CSF		
Variable	Mean	[95% Confidence Interval]		Mean	[95% Confidence Interval]	
Sample						
Peak power outage	−1.28	−1.41	−1.16	−3.71	−4.43	−2.99
Off-Peak power outage	−0.64	−0.71	−0.57	−1.84	−2.20	−1.49
SCA (1 000 ha)	1.47	1.32	1.62	3.89	3.13	4.65
CCA (1 000 ha)	4.92	4.43	5.42	14.98	12.12	17.85
ID				0.26	0.24	0.28
Amhara						
Peak power outage	−1.14	−1.33	−0.96	−0.86	−1.04	−0.67
Off-Peak power outage	−0.58	−0.67	−0.48	−0.42	−0.50	−0.34
SCA (1 000 ha)	1.32	1.10	1.53	0.89	0.71	1.08
CCA (1 000 ha)	4.41	3.69	5.13	3.46	2.74	4.17
ID				0.42	0.39	0.45
Tigray						
Peak power outage	−1.42	−1.59	−1.24	−6.42	−7.72	−5.11
Off-Peak power outage	−0.70	−0.80	−0.61	−3.19	−3.84	−2.55
SCA (1 000 ha)	1.61	1.40	1.82	6.74	5.36	8.12
CCA (1 000 ha)	5.41	4.72	6.09	25.93	20.71	31.15
ID				0.11	0.10	0.12

this leads to a lower marginal WTP for all the attributes. This can be further illustrated in Fig. 3B, which shows that the marginal utility of price between Amhara and Tigray using average ID measures and median per capita income (650 ETB per month). An important finding of this investigation is that price has a negligible effect with high trust (Fig. 3B, solid line for Tigray) and has a deleterious effect with relative high distrust value (Fig. 3B, broken line for Amhara) for the choice of policy alternatives. In conclusion, the disparity of marginal utility of price between Tigray and Amhara could be easily misinterpreted as the marginal utility of income if we didn't account for ID in our analysis.

So far, we have sought to understand the effect of ID, price and income on marginal utility of price in our proposed model (SC-CSF). The next logical question is how the marginal utility of price from SC-CSF model is comparable with the RPL estimate? To answer this question, we present the density of marginal utility of price for both models using the actual data in Fig. 4. The figure shows that the marginal utility of price is close to zero for most people in the SC-CSF model compared to the RPL. This eventually leads to a disparity on a welfare estimate between the two models. We elaborate on this in the next section.

4.3.1. *Empirical welfare estimate result*

One of the major objectives of this paper is to show the importance of accounting for choice set formation when evaluating WTP. For this, we focus on marginal WTP of attributes. The marginal WTP shows how much increase or decrease in price would be required to change one unit in an attribute. To clarify the consequences of ID in WTP estimates, we focus on the marginal WTP for each attribute for the total sample and the Amhara and Tigray sub-groups. In Section 4.1 and Fig. 1, we have shown that there is a large difference in ID between the people of Amhara and Tigray, which has a large differential effect on the marginal utility of price (Section 4.3). Here, we present the results of the average marginal WTP for power outage reduction and watershed management attributes (Table 4).

Table 4 shows the average marginal willingness to pay (WTP) estimates and confidence intervals for the attributes for the RPL and SC-CSF models for the sample and the two regions (Amhara and Tigray). The sample marginal WTP shows that in absolute terms the estimates are higher for the SC-CSF model than the RPL model. A further analysis shows that the two models provide the same welfare estimate with higher ID value (Amhara). However, RPL model underestimates welfare by a factor of 4.5 when individuals have a lower ID value (Tigray). WTP for all attributes are affected equally as the ID enters in the choice set formation process.

The average marginal WTP to avoid 1 h peak and off-peak power outages in Amhara is about 13.4% of what it is in Tigray. Similarly, the average marginal WTP for managing 1000 ha of SCA or CCS in Amara is about 13.2% of what it is in Tigray. Thus, respondents from Amhara may appear to have a high marginal utility of income if the analyst ignore ID, but taking ID into account reveals that the results are driven by this belief (Table 4). Consequently, aggregation of average marginal WTP values over these samples will lead to underestimation of WTP.

5. Conclusion

We have addressed the question of how to incorporate ex post possible institutional distrust (ID) in stated preference studies when this is inherent in the institutions offering policies of public good provision and therefore not possible to eliminate through survey design, e.g., by choosing a different payment vehicle collector.

We develop a semi-compensatory model of hybrid choice that enables us to discriminate the effect of a budget constraint from that of institutional distrust in choice set formation and welfare impacts. Based on our empirical data, the model is superior in terms of model fit and out of sample data prediction compared to standard Random Parameter Logit (RPL) model.

We collected data from Ethiopia, for which there is strong evidence of widespread perceived level of corruption in various sectors of its economy. Based on our data and model results, we show that the willingness to allocate personal budget for public goods (such as power outages and soil conservation) decreases as the level of ID increases. We also compared our model with a RPL model. The two models provide the same conclusion when respondents have a higher ID. However, welfare estimate disparity increases between the two models when respondents have a low ID (high trust). Empirically, we found that in the two Ethiopian cities sampled, Amhara and Tigray, the avarage levels of the institutional distrust construct are 0.42 and 0.11, respectively, which in context implies that levels of ID are quite high (see Fig. 1). Overall, the RPL model provides lower marginal willingness to pay for all attributes compared to our proposed model.

The mechanism for ID having an impact is through the elimination/screening of proposed projects from the respondent's choice set. We show that it is important to account for ID in welfare estimates. It is a standard assumption that WTP for public goods increases with income; however, in the presence of high instructional distrust, an increase in income may not have any effect, i.e., in absolute terms the WTP is very small, or even zero. In conclusion, high marginal utility of price could be easily misinterpreted as the marginal utility of income if we didn't account for ID in our analysis. Based on our work, we recommend that WTP studies test for ID as part of the analysis in a country where legislative and regulatory institutions are perceived to be endemically corrupt.

This study also shows that ID induced choice set formation is more dominant than the direct price effect for welfare change. In absolute terms, the direct price effect has a negligible effect on the utility of policy alternatives. Thus, for individuals with low ID, the price attribute levels given in the CE may not cover the full extent of demand. The implication is that a geographical-specific pre-test of the survey instrument may be needed to gauge attribute levels for the final CE survey. Suppose there is a substantial difference among regions. In that case, a split-sample design with a differentiated attribute level for the price should be used to capture the full extent of demand (Kassahun et al., 2020b).

Furthermore, although the direct price effect is low for alternative consideration in the current study, a combined higher direct price and ID induced choice set effects will likely have a high chance of total rejection of policy alternatives. In this case, researchers may consider if an alternative payment vehicle that is less prone to corruption is suitable for valuation purposes (Kassahun et al., 2020a). To better understand cases where both direct price effect and ID induced choice set effects are present, it could be an idea to carry out simulation studies to investigate the effects on welfare estimates.

Author contributions

Survey development and data collection was undertaken by Habtamu Tilahun Kassahun and Jette Bredahl Jacobsen. The model design, estimation and analysis were performed by Habtamu Tilahun Kassahun and Joffre Swait. The manuscript was drafted by Habtamu Tilahun Kassahun and critically revised by Joffre Swait and Jette Bredahl Jacobsen. All authors read and approved the final manuscript.

Declaration of competing interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Appendix 1. A short historical background information on the Ethiopian government

The data we used to demonstrate the model presented in this article was collected between October and December 2012 from Amhara and Tigray regional states in Ethiopia. Given that the study's focus was on the impact of institutional distrust. Below, we provide short historical background information on the Ethiopian government to provide a context for the level of institutional distrust in Amhara and Tigray national regional states.

In 1991, the Tigrayan People's Liberation Front (TPLF), backed by the Eritrean People's Liberation Front (EPLF), overthrew the military government and took power in Ethiopia "in the name of the Ethiopian People's Revolutionary Democratic Front (EPRDF)." EPRDF was composed of three ethnic groups: the Oromo Peoples' Democratic Organization (OPDO), the Amhara National Democratic Movement (ANDM) and TPLF, and one multiethnic group: the South Ethiopian Peoples' Democratic Front (SEPDF). However, EPRDF was often referred to as the 'Tigrayan front' because of the dominant position of the TPLF in government and vital military positions (Berhe, 2004; Habtu, 2005; Ishiyama, 2012). Ishiyama (2012) summarizes the relationship between the TPLF and other members of EPRDF in the Ethiopian government as follows: "*All four regional-ethnic parties were created by the TPLF and formed the EPRDF. In reality, members of parliament from these parties consistently vote with TPLF and have no real independence outside the direction of TPLF. In addition, the parties enjoy no real* support *from the regions they are supposed to represent. As a result, therefore, real power and direction of EPRDF continues to be with members of the TPLF core leadership.*"

Discontent with the continuous dominance of TPLF and accompanied by the surge of a massive protest in the Amhara and Oromia regions of Ethiopia, representatives from ANDM and OPDO united forces to outmaneuver TPLF within the collation for the first time in 27 years in 2018.[16] On April 2, 2018, the House of Peoples' Representatives elected Abiy Ahmed, the 2019 Noble Prize for peace winner, as prime minister of Ethiopia.

Appendix 2. Relationship between hydropower production and watershed management

The Ethiopian Electric Power Corporation is almost entirely dependent on hydropower to supply electric power to domestic households and industries. Any negative factor that affects the watershed directly affects the volume and the quality of water in hydroelectric power reservoirs. Consequently, water shortage related power outage and the rationing of power are typical during the dry season. On the other hand, energy demand is expected to grow by 32%. Currently, the Grand Ethiopian Renaissance Hydropower Dam on the Blue Nile River is under construction, with the primary objective of satisfying growing demand and reducing current and expected power outages due to loss of capacity at existing power plants. The newly designed dam's power generation capacity plays a

16 https://www.theguardian.com/world/2020/nov/25/rise-and-fall-of-ethiopias-tplf-tigray-peoples-liberation-front.

crucial role in reducing current and expected power outages. With full capacity, water shortage related power outages may be significantly reduced. However, previous studies and observations of the Nile River System show that reservoirs' capacity loss is very rapid due to reservoir sedimentation. This is because of enormous soil erosion problems originating in the Amhara and Oromia regions of the Upper Blue Nile Basin of Ethiopia. For example, in Sudan near the Ethiopian border and very close to the Grand Ethiopian Renaissance Hydropower Dam construction site, Rosier reservoir has shown a rapid loss of capacity and power generation. Therefore, it is doubtful that the Grand Ethiopian Renaissance Hydropower plant will operate at full capacity without improving the watershed health. This requires considerable budget support from citizens who are connected to the electricity service.

Appendix 3. Example of choice card

	Alternative 1	Alternative 2	Status Quo
Weekly power outage	For 10 hours & 30 Minutes	For 7 hours	For 21 hours
Peak power outage	Yes	No	Yes
Off-peak power outage	Yes	Yes	No
Area covered by integrated soil conservation and afforestation measure	225,000 ha	300,000 ha	No additional measure
Free grazing area converted to cut and carry system	18,000 ha	24,000 ha	No additional measure
Additional monthly payment	44 Birr	66 Birr	0 Birr
Choose here	☐	☐	☐

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