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Dokumentation der Ko-Autorenschaft

Das 1. und 5. Kapitel der vorliegenden Dissertation wurde in Alleinautorenschaft verfasst.

Kapitel 2 wurde zusammen mit Menglu Neupert-Zhuang verfasst. An der Konzeption der Studie waren beide Autoren in gleichem Maße beteiligt. Die Datenerhebung, -aufbereitung und -analyse wurde von mir durchgeführt. Das Kapitel wurde in Kooperation mit Menglu Neupert-Zhuang verfasst. Daher sind ca. 70% dieses Kapitels mir anzurechnen.

Kapitel 3 wurde gemeinsam mit Björn Vollan, Myriam Hadnes und Michael Kosfeld verfasst. An der Konzeption der Studie, sowie der Datenerhebung waren Björn Vollan, Myriam Hadnes und Michael Kosfeld beteiligt. Die Datenanalyse sowie das Verfassen des Kapitels wurde von Björn Vollan und mir durchgeführt und mit Michael Kosfeld abgestimmt. Daher sind ca. 30% dieses Kapitels meiner Autorenschaft zuzurechnen.

Kapitel 4 wurde gemeinsam mit Johannes Linde und Björn Vollan verfasst. An der Konzeption der Studie waren Björn Vollan und ich beteiligt. Die Datenerhebung wurde von mir durchgeführt. An der Datenanalyse und dem Verfassen des Kapitels waren Johannes Linde und ich beteiligt. Daher sind ca. 60% dieses Kapitels meiner Autorenschaft zuzurechnen.

Kapitel 6 wurde gemeinsam Julian Rode, Tobias Vorlaufer und Björn Vollan verfasst. An der Konzeption der Studie waren Björn Vollan und ich beteiligt. Die Datenerhebung wurde von mir durchgeführt. An der Datenanalyse waren Tobias Vorlaufer und ich in gleichem Maße beteiligt. Am Verfassen des Kapitels waren alle Autoren zu gleichem Maße beteiligt. Daher sind ca. 40% des Kapitels mir anzurechnen.

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Zusammenfassung

Im ersten Kapitel der vorliegenden Dissertation werden die restlichen Kapitel thematisch zusammengeführt. Der thematische Zusammenhang der einzelnen Kapitel basiert hierbei auf deren Einordnung in den exemplarischen Zyklus eines Finanzierungsprojektes zur Förderung nachhaltiger sozioökonomischer Entwicklung im globalen Süden. Außerdem wird die kapitelübergreifende Relevanz von Umweltpräferenzen dargelegt. Nach einer kurzen Motivation dieses thematischen Kontexts, sowie einigen Ausführungen über die globale Relevanz solcher Finanzierungsprojekte, werden die einzelnen Kapitel und deren Ergebnisse entlang des Projektzyklus kurz zusammengefasst und jeweils konzeptionell eingeordnet.

Das zweite Kapitel der vorliegenden Dissertation, verfasst von Menglu Neupert-Zhuang und mir, behandelt eine experimentelle Evaluierung der Nachhaltigkeitspräferenzen von Kleinanleger*Innen und wie diese durch verschiedene Arten von Information über die Nachhaltigkeit bestimmter Finanzprodukte beeinflusst werden. Die Nachhaltigkeitspräferenzen werden hierbei hauptsächlich über die durchschnittlichen Präferenzen für ein Europäisches Umweltzeichen approximiert. Umweltzeichen für Finanzprodukte können bei Kleinanleger*Innen dazu beitragen, Informations- und Vertrauenslücken im Hinblick auf die Nachhaltigkeit dieser Produkte zu schließen. Die genauen Mechanismen wie Kleinanleger*Innen ihre Anlagepräferenzen in Reaktion auf solche Zertifizierungen anpassen, sind jedoch kaum erforscht. Meine Ko-Autorin und ich präsentieren die Ergebnisse eines eigens entworfenen Online-Experiments über die diskrete Auswahl zwischen verschiedenen Aktienfonds ein, um die Präferenzen potenzieller Kleinanleger*Innen für umweltzertifizierte Anlagefonds zu ermitteln. Dieses Experiment wurde mit zusätzlichen experimentellen Informations-Treatments zwischen den Versuchspersonen kombiniert. Basierend auf den Überlegungen zur Gestaltung des EU-Umweltzeichens für Finanzprodukte variieren wir hierbei zwischen dem spezifischen Informationsgehalt über die Nachhaltigkeit des Zeichens, sowie der Menge an Nachhaltigkeits-Informationen, die mit dem Zeichen in Verbindung angezeigt werden. Wir führen zusätzliche Variation ein, indem wir die Art und Weise der grafischen Darstellung anpassen, durch die den Befragten quantitative Informationen über die Nachhaltigkeit des jeweiligen Anlagefonds präsentiert werden. Unsere Ergebnisse deuten darauf hin, dass die Bereitstellung zusätzlicher Nachhaltigkeitsinformationen und motivierender Botschaften zum nachhaltigen Handeln in Verbindung mit dem EU-Umweltzeichen einen signifikanten und positiven Effekt auf die durchschnittlichen Präferenzen für dieses Zeichen hat. Wir finden außerdem, dass hervorgehobene und intuitiv veranschaulichte Informationen über die Nachhaltigkeitsleistung eines Fonds einen Spillover-Effekt auf Anlegerpräferenzen für das Umweltsiegel selbst zu haben scheinen. Dies unterstreicht die Relevanz von Framing-Effekten, die auf visuellen Anreizen zusätzlich zum Informationsgehalt des Umweltzeichens selbst beruhen. Die

Ergebnisse des Experiments verdeutlichen die Rolle solcher Effekte bei der Überbrückung von Verhaltensbarrieren beim nachhaltigen Anlageverhalten von Kleinanleger*Innen.

Das dritte Kapitel, verfasst von Björn Vollan, Myriam Hadnes, Michael Kosfeld und mir, behandelt die Rolle sozioökonomischer und kultureller Dynamiken und Normen, welche bereits in der kurzen Frist einen starken Einfluss auf die Effektivität von Finanzierungsmaßnahmen zur nachhaltigen sozioökonomischen Entwicklung haben können. Hierzu wurde ein Feldexperiment in Burkina Faso durchgeführt, um die Auswirkungen informeller Teilungsverpflichtungen innerhalb von Verwandtschaftsnetzwerken auf unternehmerischen Bemühungen zu untersuchen. Die Unternehmer*Innen, in diesem Fall Schneider*Innen, erhielten im Rahmen des Experiments einen ökonomischen Anreiz Taschen zu produzieren. Unsere experimentelle Intervention bestand darin, die Familien der Schneider*Innen auf subtile Art und Weise über diese Einkommensmöglichkeit zu informieren, um dadurch Teilungsverpflichtungen innerhalb des Verwandtschaftsnetzwerks zu aktivieren. Die Erwartung war hierbei, dass das Informieren der Familienmitglieder zu einem durchschnittlichen Rückgang der unternehmerischen Anstrengungen (Anzahl der produzierten Taschen) führen sollte. Der von uns gefundene Gesamteffekt der Behandlung ist jedoch nicht signifikant, und weist sogar in die entgegengesetzte Richtung als erwartet. Eine explorative ex-post Analyse, die sich auf frühere Forschungsergebnisse stützt, zeigt jedoch, dass diese durchschnittlichen Effekte interessante Unterschiede bei der Anpassung der Produktionsprozesse der Schneider überdecken. Die Heterogenität zwischen den beiden experimentellen Gruppen in Bezug auf die Verlängerung der Arbeitszeit zur Produktion der Taschen, sowie das Integrieren zusätzlicher Personen in die Taschenproduktion unterstreicht die Bedeutung von Reziprozitätsnormen und dem Verstecken von unternehmerischem Einkommen, welches zuvor bereits in anderen Experimenten nachgewiesen werden konnte. Darüber hinaus deuten die experimentellen Ergebnisse darauf hin, dass einige Schneider*innen in der Treatmentgruppe ihr Verwandtschaftsnetzwerk zu ihrem gemeinsamen Vorteil aktivieren konnten, was letztlich das positive Potenzial von Verwandtschaftsnetzwerken in einem unsicheren Unternehmensumfeld unterstreicht.

Das vierte Kapitel der vorliegenden Dissertation, verfasst von Johannes Linde, Björn Vollan und mir, beleuchtet die Nachhaltigkeitsimplikationen von Finanzierungsprojekten zur Förderung nachhaltiger Entwicklung mit speziellem Fokus auf die sozioökonomischen Wirkungseffekte und die ökologische Effizienz von Solarelektrifizierungsmaßnahmen in ländlichen Gebieten des globalen Südens. Der Verbreitung von Solar-Kleinanlagen zur Elektrifizierung von Haushalten in solchen Gebieten wird in der Erreichung des Ziels der universellen Elektrifizierung (Teil der nachhaltigen Entwicklungsziele der Vereinten Nationen) eine wichtige Rolle zugeschrieben. Die sozioökonomischen Auswirkungen solcher Elektrifizierungsprojekte sind jedoch kaum erforscht, und wenn mit gemischten Ergebnissen belegt, während ihre Implikationen im Hinblick auf ökologische Nachhaltigkeit zumeist nur mit Simulationsstudien untersucht werden. Die vorliegende Studie liefert Belege für die langfristigen

Auswirkungen von Solarelektrifizierungsprojekten in Bezug auf beide Teilaspekte der sozioökologischen Nachhaltigkeit. Unsere Analyse basiert hierbei auf einer Befragung von 1.206 Haushalten im südlichen Sindh, Pakistan, von denen die Hälfte ein Jahrzehnt zuvor im Rahmen einer groß angelegten Entwicklungsinitiative mit einer Solar-Kleinanlage ausgestattet wurde. Wir verwenden den quasiexperimentellen Ansatz des Propensity Score Matching mit Overlap-Weighting, um die sozioökonomischen Auswirkungen der Solarversorgung zu untersuchen, während die Umweltperformanz des Projekts durch eine Analyse der energetischen Amortisationszeit der Kleinanlagen approximiert und evaluiert wird. Während wir eindeutige Beweise für eine Auswirkung des Elektrifizierungsprojekts auf sozioökonomische Indikatoren wie die Nutzungsdauer von Glühbirnen und Lernzeiten von Kindern finden, hängen diese Effekte jedoch stark davon ab, ob die Haushalte in der Lage waren, die Solaranlagen von der Projektdurchführung bis zum Zeitpunkt der Haushaltsbefragung zu in Betrieb zu halten. Durch den Umstand, dass dies lediglich auf ein Drittel der Haushalte in unserer Stichprobe zutrifft, wird auch die allgemeine ökologische Nachhaltigkeit des Elektrifizierungsprojekts negativ beeinflusst.

Die letzten beiden Kapitel der vorliegenden Dissertation behandeln die potenziellen langfristigen Implikationen von Finanzierungsprojekten zur Förderung nachhaltiger Entwicklung auf individuelle Nachhaltigkeitspräferenzen. Das fünfte Kapitel, verfasst von mir in Alleinautorenschaft, behandelt die Auswirkungen des aus dem vorherigen Kapitel bekannten Elektrifizierungsprojektes auf die Nachhaltigkeitspräferenzen der Nutzer der Solar-Kleinanlagen. Im Mittelpunkt der Problematik steht hierbei, dass im Rahmen von Elektrifizierungsinitiativen in ländlichen Gebieten einkommensschwacher Länder häufig Solar-Kleinanlagen mit fragwürdiger Komponentenqualität verbreitet werden. Außerdem ist die Nachbetreuung der Begünstigten Haushalte nach der anfänglichen Verteilungsphase der Anlagen oft mangelhaft, während lokale Märkte mit minderwertigen Ersatzprodukten überschwemmt werden. Probleme dieser Art wirken sich potenziell negativ auf die Präferenzen für Solarenergiegeräte unter den neuen Technologieanwendern aus und behindern so die langfristige Entwicklung nachhaltiger und selbsttragender Solarmärkte, während sie gleichzeitig zu einer Abneigung der ländlichen Bevölkerung gegenüber erneuerbaren Energiesystemen führen können. Das Kapitel beschreibt die Durchführung und Ergebnisse eines Discrete-Choice-Experiments im südlichen Sindh, Pakistan. Das Experiment hatte zum Ziel zu untersuchen, wie individuelle Präferenzen für verschiedene Eigenschaften von Solar-Kleinanlagen, darunter zwei verschiedene Nachhaltigkeitssiegel, durch frühere Erfahrungen mit solchen Anlagen beeinflusst werden. Zusätzliche experimentelle Variation wurde in Form von Sensibilisierungsvideos eingeführt, um herauszufinden, wie Interventionen dieser Art die Nachhaltigkeitspräferenzen kurzfristig beeinflussen können. Während die Ergebnisse auf positive durchschnittliche Konsumentenpräferenzen für beide Nachhaltigkeitssiegel hindeuten, variieren diese in der Tat signifikant mit heterogenen persönlichen Erfahrungen mit Solar-Kleinanlagen. Die Ergebnisse des Experiments zeigen potenzielle Probleme in Bezug auf langfristige

Nachhaltigkeitsimplikationen von Elektrizitätsinfrastrukturprojekten mit mangelhafter Umsetzung und Nachbetreuung auf.

Das letzte Kapitel der Dissertation, verfasst von Julian Rode, Tobias Vorlaufer, Björn Vollan und mir, stellt einen vornehmlich methodologischen Beitrag dar, in dem Nachhaltigkeitspräferenzen als langfristiger Indikator für die Wirkung von Naturschutzpolitik in ländlichen Gebieten des globalen Südens diskutiert wird. In der akademischen Forschung, die sich mit den Auswirkungen von Naturschutzmaßnahmen befasst, wird gemeinhin anerkannt, dass das Verhalten lokaler Nutzer natürlicher Ressourcen nicht nur durch wirtschaftliche Anreize beeinflusst wird, sondern auch durch eine Reihe von individuellen Motivationen, sowie diesen zugrunde liegenden Werten. Vor allem in Fällen, in denen die Politik nicht gewährleisten kann, initiale finanzielle Versprechen an die lokale Bevölkerung zu erfüllen, sind solche nicht-monetären Faktoren entscheidend für die Sicherung langfristiger positiver Naturschutzergebnisse. Die Messung und Entflechtung dieser Faktoren stellt jedoch nach wie vor eine große Herausforderung dar. Wir stellen einen konzeptionellen und methodischen Beitrag vor, der seine Wurzeln in den Wirtschaftswissenschaften hat, um dieses Problem anzugehen. Zunächst wird das Konzept der "Erhaltungspräferenzen" eingeführt, dass die individuellen Motivationen und Kompromisse, die mit nachhaltigen Entscheidungen auf individueller Ebene verbunden sind, umfasst. Aufbauend auf den Erkenntnissen etablierter Methoden, wie z.B. Einstellungs- oder Verhaltensmessungen, stellen wir einen neuartigen und praktischen Ansatz zur Messung von Naturschutzpräferenzen vor, der auf Methoden der kontingenten Bewertungsmethode, sowie Spendenaufrufen im experimentellen Rahmen basiert. Wir veranschaulichen unseren Ansatz im Rahmen einer Fallstudie im Norden Namibias, wo er eingesetzt wurde, um zu untersuchen, ob die Teilnahme an einem gemeinschaftsbasierten Naturschutzprogramm einen langfristig messbaren Einfluss auf die individuellen Naturschutzpräferenzen hat. Unsere Ergebnisse zeigen, dass unser Ansatz eine geeignete Ergänzung oder gar ein Ersatz für etablierte Messgrößen für Naturschutzpräferenzen sein kann, da einige der bekannten Fallstricke wie Nachfrageeffekte oder kostspielige Datenerhebungen im Zusammenhang mit Verhaltens- und Einstellungsmessungen vermieden werden können.

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Chapter 1 - Synopsis: On the Socioecological Implications of Sustainable Development Projects and the Role of Environmental Preferences

by

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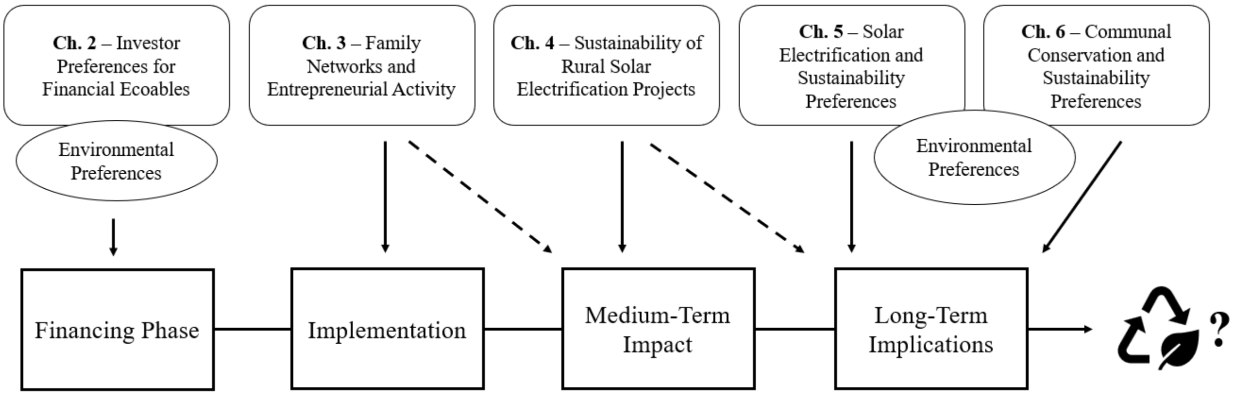
1.1. Climate Change Mitigation Through Financing Sustainable Development

In the context of humanity's efforts against the ever-increasing adversities resulting from global climate change, it has long been clear that the decarbonization of the international energy system is in demand of substantial financial investments (Buchner et al., 2019). In this context, climate finance is typically defined as the financing of low-carbon energy projects that should aim to increase society's resilience against adverse climate change effects (Hong et al., 2020), especially among those living in highly exposed regions in the Global South (Steckel et al., 2017). While the need for climate finance has long been acknowledged and reiterated, at the latest with its increased endorsement in the context of the Paris agreement, today the concept is discussed in a more controversial manner. This is mostly due to ambiguities about what even counts as an investment in the spirit of climate finance (Weikmans & Roberts, 2017) or simply based on the fact that developed countries have not delivered on earlier financial promises (Roberts et al., 2021). As the climate finance cycle is typically characterized by financial flows from richer countries of the Global North to poorer and more exposed countries in the Global South, another crucial issue brought forward in academic literature is that many of the funds directly aimed at climate mitigation actions dissipate as recipient countries face tradeoffs in which they often prefer actions to foster socioeconomic development over those in favor of climate mitigation (Eyckmans et al., 2016; Winkler & Dubash, 2015). Based on this notion, effective international climate mitigation funding should optimally account for both climate change mitigation, as well as socioeconomic development objectives in recipient countries of financial aid flows – sustainable development finance instead of climate finance (Steckel et al., 2017). In an optimal scenario, as with any other financial investment, the invested funds should yield returns somewhere down the line, which in the case of sustainable development finance would require tangible sustainable development outcomes in response to these investments in the first place.

The research articles included in this dissertation pick up precisely on this point in that they investigate the sustainability and development implications of different sustainable development finance projects at various phases of the project cycle. An additional focal point shaping the work presented in this dissertation revolves around the concept of environmental preferences, as well as their specific role in the context of sustainable development projects. In economics, preferences are typically defined as an individual ordering of alternatives based on their relative utility to the agent in question. Thus, when an individual, relative to others, has strong preferences for environmental or sustainability causes, e.g., issued through an engagement for ecological causes or statements reflecting a high valuation of nature, this person can be said to have environmental preferences. While in classical economics, such preferences are typically regarded as stable on the individual level, contributions from the last three decades have challenged this notion, coining the term endogenous preferences in the process (Bowles, 1998; Mattauch & Hepburn, 2016). Preferences are called endogenous when they can be influenced by external factors. Following the assumption of endogenous preferences, this dissertation will examine the measurement and significance of environmental preferences in the context of sustainable development projects. The research results will show how environmental preferences can change in response to how well such projects are implemented, which in turn highlights their role in reflecting or even influencing the social and ecological implications of sustainable development projects in the long run.

Against this backdrop, Figure 1.1 illustrates the rationale for the ordering of chapters within this manuscript, which is based on an exemplary sustainable development finance project flow. As an example, the second chapter of this dissertation concerns the financing phase of sustainable development finance projects, while also directly addressing and utilizing the concept of environmental preferences. As indicated by the sequential illustration of the sustainable development finance cycle, the remaining chapters are more concerned with the social and environmental implications of sustainable development finance projects once the money has been put to use on the ground (i.e., concerning a project's implementation and medium- to long-term impact). How the research articles included in this dissertation examine implications will be elaborated on in more detail in the following two subchapters.

Figure 1.1 – Sequence of Dissertation Chapters Along the Sustainable Development Finance Project Cycle



Note: Where indicated, the concept of environmental preferences is central to the respective chapter.

Firstly however, as indicated in Figure 1.1, the second chapter of this dissertation, co-authored with Menglu Neupert-Zhuang, alludes back to the initial problem stated in this subchapter: International climate mitigation endeavors are hampered by substantial financing gaps (Buchner et al., 2019). In addition to this consensus, it is also apparent that the majority of these financing gaps in fact need to be filled by the private sector (Bhandary et al., 2021; Steckel et al., 2017). Next to financial investments of private companies, a factor on this end can of course be an increased mobilization of retail investments in sustainable financial products (Wins & Zwergel, 2016). However, academic research indicates that even if private retail investors are interested and willing to invest money into funds of this type, actually following up on this intention is subject to different kinds of obstacles, which explains why retail investors, as of now, only play a marginal role in the sustainable investment market (Forum Nachhaltige Geldanlage e.V., 2021). While fears of false sustainability claims (or "greenwashing") and lower returns relative to conventional investment products have been identified as barriers hampering sustainable retail investments (Dupre et al., 2020; Sharma & Kushwaha, 2019; Spencer et al., 2019), another obstacle lies in the information costs associated with an adequate assessment of a financial product's sustainability implications (Avramov et al., 2021; Frydman & Camerer, 2016; Gutsche & Zwergel, 2020). The online experiment presented in the second chapter of this dissertation is concerned with how additional and/or differently framed sustainability information associated with an investment fund can potentially help in bridging such barriers. More specifically, we investigate how sustainability preferences are affected by different information treatments in the context of a hypothetical online discrete choice experiment (DCE). In the context of this study, we proxied sustainability preferences by an increased tendency among retail investors to choose funds with an EU-Ecolabel certification and/or a higher share of "green" economic activity as indicated in the fund's description. Through the inclusion of between-subject informational treatments and the use of an ecolabel referring to a real-world entity (in this case, the European Union (EU)), our experiment builds and expands on three specific studies which previously investigated retail investor preferences for sustainable financial products using DCE methodology (Bassen et al., 2019; Gutsche & Ziegler, 2019; Lagerkvist et al., 2020).

Our results indicate that the provision of additional sustainability information and motivational messages alongside the EU Ecolabel in fact explains a significant and positive increase in average sustainability preferences. However, further analysis suggests that this effect is mainly driven by the visual prominence of the treatment intervention, rather than the content of the sustainability information itself. While further (incentivized) research in this field is surely needed, our results provide a strong indication that the aforementioned barriers to realizing sustainable retail finance potential can be at least partially overcome by straightforward and digestible sustainability information from a trustworthy source, thereby providing help in bridging sustainable development finance gaps.

1.2. Social and Ecological Implications of Sustainable Development Projects

Once sustainable development funding is raised, this money should then of course be put to use in a manner that can fulfill sustainable development objectives and promises. One example would be to invest the funds in fostering socioeconomic development in the Global South, e.g., through fueling the entrepreneurial activity of small- and medium-sized enterprises (SMEs). However, academic literature provides clear evidence that, already in the short-term, the effectiveness of such projects can be severely hampered by entrepreneurial disincentives rooted in informal sharing obligations within extended family networks (Alby et al., 2020; Alger & Weibull, 2010; Di Falco & Bulte, 2011; Fafchamps, 2004; Grimm et al., 2013; Hoff & Sen, 2006; Platteau, 2000). As such obligations continue to play a significant role in many regions of the Global South, for sustainable development projects involving SME development to be implemented effectively, a deeper understanding of the dynamics between family network ties and entrepreneurial activity is of specific importance.

As indicated in Figure 1.1, the third chapter of this dissertation, co-authored with Björn Vollan, Myriam Hadnes, and Michael Kosfeld, provides evidence from a field experiment conducted in Burkina Faso that is concerned with exactly these dynamics. Expanding on previous experimental (Ashraf, 2009; Bulte et al., 2018; Di Falco et al., 2018; Dupas & Robinson, 2013; Jakiela & Ozier, 2016) and survey-based studies (Baland et al., 2011, 2016; Di Falco & Bulte, 2011, 2013), we provide the first evidence from a field experiment conducted with entrepreneurs in their natural business environment. We offered financial incentives to tailors who participated in our study, intending to replicate a real-life task similar to their regular business activities. This task involved the production of standardized bags. To examine the impact of sharing norms within family networks on entrepreneurial activity, we experimentally varied whether a family member of the tailor was informed about this novel income opportunity or not. Thereby, we were able to directly manipulate a tailor's ability to conceal experimental payouts from their family network. Our results do not show an average effect of our experimental treatment on bag production. However, explorative analysis based on previous research findings indicates significant heterogeneity between both experimental groups relating to the mode of how tailors adjusted their production process in the context of the experimental income opportunity. Relative to control group tailors, tailors in the treatment group asked more people for help in the bag production and were also better able to cope with problems occurring during the production process, indicating that family networks can in fact provide insurance in uncertain business environments – while family networks might demand redistributive taxes, they will also provide help in case it is necessary.

Even if potential short-term impediments to reaching sustainable development outcomes, such as the ones outlined in chapter 3, can be overcome, a subsequent question is whether these outcomes do actually manifest to a significant degree. Solar electrification endeavors in rural areas of the Global South provide an intriguing example for sustainable development projects, as their appeal rests within the sustainable development duality itself. This is because solar electricity, when compared to fossil-based power sources, produces no emissions during energy production, while its dissemination is also relatively cheap when compared, e.g., to the extension of overland gridlines (Adenle, 2020; Szabó et al., 2011). Additionally, during the past decade, the role of rural electrification as a driver of socioeconomic development has been pointed out and investigated in academic literature (Cook, 2011; Dinkelman, 2011; Komatsu et al., 2011; Wamukonya, 2007). However, especially in the case of rural electrification programs involving small-scale solar systems provided on the household level (so-called Pico-Photovoltaic or Solar Home Systems (SHS)), the evidence regarding both sides of the sustainable development duality is surprisingly thin. While most studies concerned with the socioeconomic impact of such interventions are able to identify significant effects on educational outcomes (Bensch et al., 2013; Grimm et al., 2017; Hassan & Lucchino, 2016; Samad et al., 2013), reported effects on financial indicators of socioeconomic development are mostly small if detected at all (Aklin et al., 2017; Grimm et al., 2017; Samad et al., 2013; Wagner et al., 2021). Regarding the environmental sustainability of rural solar electrification projects, many studies investigate the implications of SHS dissemination projects using assumption-driven simulation studies instead of evaluating the long-term outcomes of real case studies (Antonanzas-Torres et al., 2021; Azimoh et al., 2014; Diouf & Avis, 2019).

Chapter 4, co-authored with Johannes Linde and Björn Vollan, provides novel evidence on the aforementioned duality in investigating both the social and ecological implications of a large-scale SHS electrification project in Sindh, Pakistan, about one decade after the initial SHS dissemination phase concluded. We employ quasi-experimental methodology to estimate the socioeconomic impact of the solar electrification project in question, while its environmental implications are examined by evaluating

SHS energy payback times (EPT) based on life-cycle assessment calculations and electricity usage patterns observed in the field. Both the socioeconomic and environmental conclusions drawn from our analysis are strongly dependent on whether households were able to sustain their SHS from the time of the initial dissemination up to the point of our household survey, with average socioeconomic impacts only being detectable among households that reported to still be using the SHS at the time of our household survey. Likewise, the disseminated SHS can only reasonably be expected to reach sustainable EPT thresholds in the same group of households. Only one-third of households in our case study were able to maintain their SHS for a period of approx. ten years (with technical malfunctions being cited as the primary reason for this), highlighting the crucial significance of taking follow-up service and supervision seriously when aiming for a sustainable bottom-line in the evaluation of rural electrification projects.

1.3. Environmental Preferences and Long-Term Sustainability Implications of Sustainable Development Projects

The final two chapters again put the concept of environmental preferences into focus. As the findings from chapter 4 already suggest, long-term sustainable development implications of rural solar electrification projects are crucially dependent on consistent supervision and follow-up service provided to project beneficiary households. Even going beyond the socioeconomic impact and environmental performance of sustainable development projects, a subsequent question would then be how individual experiences with such projects in rural areas of the Global South reflect on individual environmental preferences. This is especially relevant in cases where initial promises of socioeconomic development (chapter 5) or an influx of economic income (chapter 6) to rural households are not universally fulfilled. In such cases, only if environmental preferences can be maintained or even fostered in response to sustainable development interventions, positive long-term sustainability implications surrounding these projects can reasonably be expected.

In chapter 5, single-authored by myself, I investigate how heterogenous exposure to SHS, as well as heterogenous experiences with SHS, reflect on preferences for solar systems in general, and sustainability preferences reflecting on SHS purchasing decisions in specific. In the context of solar electrification programs in rural areas of the Global South, positive user preferences are crucial to enable the long-term development of self-sustaining local markets (Wakkee et al., 2014), especially in cases where first-time adopters of the new technology might not have a strong sense of ownership over their SHS, as systems are often distributed free of charge or at heavily subsidized prices (Newcombe & Ackom, 2017). The above-mentioned preferences among rural households were measured in the context of a DCE on the hypothetical discrete choice between SHS characterized by different attributes, two of them representing SHS sustainability in the form of distinct product labels (one reflecting economic sustainability, the other ecological sustainability). The DCE was conducted in the context of the same household survey in Sindh, Pakistan which also provides the main data source for chapter 4 of this dissertation. The effects of heterogenous household SHS exposure and experiences on sustainability preferences are investigated by exploiting the survey's household sampling mechanism, which was motivated by quasi-experimental methodology and therefore differentiated between households that were provided with an SHS during the electrification intervention one decade earlier, and those who were not. The results indicate that the respondent sample has positive average preferences for both sustainability labels, while the heterogeneity analysis reveals significantly different preferences concerning SHS quality indicators (sustainability labels and warranty options), depending on previous experiences with SHS. While, on average, positive attitudes towards SHS increase stated preferences for these indicators, negative experiences (as indicated by previously experienced SHS product malfunction), significantly dampen this effect. Since technical issues with SHS were frequently reported in our sample, this observation puts the long-term sustainability implications of rural electrification projects involving SHS into question. As already hinted at in the results of chapter 4, the DCE outcomes further reiterate that it is crucial for agents involved in the implementation of solar electrification projects to prioritize the provision of technical service and maintenance to newly connected households if sustainable development objectives are supposed to be met in the long run.

The final chapter of this dissertation, co-authored with Julian Rode, Tobias Vorlaufer, and Björn Vollan investigates a similar question, only in the context of the community-based natural resource management (CBNRM) program in Namibia. CBNRM programs typically involve some degree of devolution of property rights over communal lands from the government to local communities. While such programs are often presented as win-win solutions, combining both the promotion of biodiversity protection and economic well-being (through the creation of jobs, eco-tourism incomes, etc.), in reality, the combination of both goals is rarely realized to a satisfactory degree (Hegwood et al., 2022; McShane et al., 2011; Muradian et al., 2013). Following the line of argumentation postulated in the context of chapter 5, especially in cases where CBNRM policies are not implemented in a manner that enables the manifestation of economic benefits to local communities, increasing or at least maintaining environmental preferences is crucial if positive long-term sustainability outcomes are to be achieved. In the context of the Namibian CBNRM program, we provide a methodological contribution on how environmental preferences (or in this case "sustainability outcomes") can be used as a measurement tool for conservation policy success. To support this contribution, we sampled respondents living in- and outside of two CBNRM conservancies located in the Kavango-East Region, Namibia. Employing a combination of hypothetical willingness-to-pay statements and donation tasks to elicit conservation preferences, we do observe slightly lower average preferences for conservation within CBNRM conservancies relative to villages located outside of these conservancies. Our study concludes that this outcome is not influenced by hypothetical bias or the specific method used for elicitation (i.e., group vs. individual deliberation). As a result, we deem our measurement approach as methodologically valid and in many regards superior to alternative measurement approaches, which are also discussed in the context of this chapter.

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Chapter 2 - Do Ecolabels for Financial Products Suffice on Their Own? An Experiment on How Sustainability Information Affects Investor Preferences

by

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Abstract: Ecolabels for financial products can help in bridging sustainability information and trust gaps among retail investors. However, the exact mechanisms of how retail investors adjust their investment preferences in response to such certifications are still poorly understood. We employ an online experiment on the discrete choice between different equity funds to elicit preferences for ecolabel-certified funds among potential retail investors (N = 1,508) and combine this with between-subject experimental treatments. Based on actual EU Ecolabel design considerations, we vary between specific informational content, as well as the amount of information attached to the label across treatment groups. We introduce additional variation by adjusting the graphical manner of how auxiliary quantitative sustainability information is presented to the respondents. Our findings suggest that providing subjects with added sustainability information and motivational messages to act sustainably attached to the EU Ecolabel has a significant and positive effect on preferences for said label. We also find that highlighted and intuitively illustrated information on a fund's sustainability performance does seem to have a spillover effect on label preferences, thereby highlighting the importance of considering framing biases based on visual cues in addition to informational content in addressing behavioral barriers in sustainable retail investment behavior.

JEL Classification: G41, G11, Q56

Keywords: Ecolabel, Investor behavior, Sustainable investment, Information treatment, Framing bias, Choice experiment

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2.1. Introduction

Enabling timely environmental protection actions and fostering global sustainable development in social and governance aspects, urgently requires a high amount of funding. Even though the global volume of Sustainable and Responsible Investments[1] (SRI) increased from 8.7 trillion US$ to 35.3 trillion US$ between 2016 and 2022 (Global Sustainable Investment Alliance, 2021), the financing gap for achieving the Sustainable Development Goals (SDGs) is still estimated to be about 3.9 trillion US$ as of 2022. This gap cannot be filled by public financing alone and directing private capital to sustainable investments becomes increasingly important (OECD, 2022). Sustainable funds integrate environmental, social, or corporate governance (ESG) criteria in the investment process. Investment funds of this type have the potential to bring about positive social impacts by shifting investments towards "greener" firms (Pástor et al., 2020) and more sustainable economic activities in general. The main clients of such funds are typically referred to as sustainable, green, or socially responsible investors (Wins & Zwergel, 2016). While institutional investors are currently the driving force in the sustainable investment market, the interest of retail investors in sustainable financial products continues to increase (Matos, 2020). Recent studies found that about 67% of French and German (Dupre et al., 2020) and 79% of US American retail investors express interest in sustainable investments in 2020 (Morgan Stanley Institute for Sustainable Investing, 2021).

Despite this positive outlook, retail investors interested in sustainable finance products still face many obstacles, preventing the market from realizing its full potential. In 2020, only about 13.1% of overall sustainable investments in Germany came from retail investors (Forum Nachhaltige Geldanlage e.V., 2021). A survey among retail investors in France and Germany indicates that 53% are still unsure about wanting to invest in sustainable funds, mostly citing the desire for exact information on how the funded activities help mitigate social and environmental issues. Further stated concerns within this survey relate to firms potentially making false sustainability performance claims ("greenwashing") and fears of lower returns compared to conventional investment products (Dupre et al., 2020; Spencer et al., 2019). Another prominent obstacle for retail investors is rooted in the information costs associated with assessing the sustainability of a given investment product (Gutsche & Zwergel, 2020). Both information acquisition and processing are not only mentally costly (Frydman & Camerer, 2016) but also financially (Avramov et al., 2021). In addition to that, the sustainability aspect of financial funds is difficult to assess because investment portfolios typically consist of investment positions in multiple firms with heterogeneous business activity profiles. One would need to know each firm's production and value chain practices and aggregate all firms' sustainable performances to fully judge the sustainability level of the financial

[1] Typically defined based as the inclusion of social criteria in the selection and management of investment portfolios (Sparkes & Cowton, 2004).

portfolio – a substantial obstacle given the complexity and heterogeneity in assessment methodologies and the amount of associated information required.

Serving as “information cues”, product labeling refers to “any policy instrument of a government or other third party that somehow regulates the presentation of product-specific information to consumers” (Teisl & Roe, 1998). Theoretically speaking, labels can reveal the information held by the companies to consumers, thus reducing the need for costly information search (Teisl & Roe, 1998). Sustainability labels for financial products, henceforth referred to as ecolabels, serve a similar purpose in that they provide nutshell information on the sustainability performance of the financial product to investors. The current landscape of labels for financial products is characterized by a multitude of entities – primarily privately-owned – each with its own system of classifying sustainability thresholds and heterogeneous application of grading criteria. For example, only 18% of the 199 sustainable funds covered in the German market are labeled (Forum Nachhaltige Geldanlage e.V., 2021). This situation induces substantial ambiguity and uncertainty for retail investors who are interested in investing in sustainable funds.

In response to these issues, a standardized EU Ecolabel for financial products with reference to the EU taxonomy for sustainable activities is currently under development. Ecolabels are supposed to evaluate “the environmental quality of a product along its lifecycle” (Houe & Grabot, 2009), while the EU taxonomy (Regulation (EU) 2020/852) is a classification system that intends to offer a common language for sustainability (EU Technical Expert Group on Sustainable Finance, 2020). The EU Ecolabel responds to the current label landscape by promising the introduction of a uniform standard into the market – otherwise, different investment portals would continue operating on different sustainability metrics (Beerbaum & Puaschunder, 2018), causing further confusion among retail investors interested in making sustainable investments.

Still, the introduction of an ecolabel for financial products and hoping for more sustainable investments simply based on its more official nature when compared to private labeling entities may not suffice on its own. In general, the effect of ecolabels for retail financial products on sustainable investment behavior is still insufficiently understood and the literature is scarce and fragmented (Drescher et al., 2014; Gutsche & Zwergel, 2020). Even more problematic, the literature on the ecolabelling of non-financial products suggests that the effect of ecolabels on influencing consumer decisions could be less than optimal. When there is little knowledge about the production process, the use of ecolabels may be regarded as greenwashing per se (Sharma & Kushwaha, 2019). Consequently, distrust in ecolabels themselves would reduce purchasing intentions (Gorton et al., 2021). Naturally, this could also affect ecolabels for financial products - if consumer knowledge of the process of matching investments to sustainable impact based on the technical taxonomy is not sufficiently transparent, it could fail to create consumer trust and become just one more label in a crowded market after all. To implement ecolabels into the market in an effective manner, it is therefore crucial to understand the demand patterns guiding sustainable investment decision-making, i.e., retail investors' preferences for sustainably labeled or certified investment products. If an investor values ESG criteria over other, alternative fund attributes (e.g., financial performance indicators) in choosing a fund for investment, one could say that they exhibit sustainability preferences.[2] Employing discrete choice experiment (DCE) methodology, a small but growing strand of recent literature concerned with this topic focuses on investigating investor preferences for sustainable labels or certifications (Bassen et al., 2019; Gutsche & Ziegler, 2019; Lagerkvist et al., 2020).[3]

As indicated by Bassen et al. (2019), a pathway to a higher degree of transparency in conveying sustainability information to retail investors, could be the disclosure of more detailed information regarding both the sustainability performance of a respective fund itself and the classification criteria of sustainability label, thereby increasing the intensive margin of said labels. We see a clear need for research to expand knowledge on investors' behavioral reactions to EU-issued ecolabels and thus potentially more trustworthy and how they are presented, in particular on how qualitative and quantitative information attached to such labels affects the investors' sustainability preferences. Against this backdrop, we employ a DCE in the context of an online survey to examine respondents' preferences and willingness to pay (WTP) for (un)sustainable funds characterized by different attributes. Employing a between-subject design, we examine the effect of information treatments and socioeconomic characteristics on these preferences, as well as potentially heterogeneous treatment effects between different respondent groups. The basis for our analysis forms an EU-wide sample of potential retail investors, i.e., a general population sample of people aged 18 or older – a design choice taken in light of the above-mentioned global need for mobilizing more sustainable finance capital from the general public, which is also one of the policy goals behind the EU Ecolabel. We analyze the gathered data using mixed logit models.

We expand on the contributions by Lagerkvist et al. (2020), Gutsche & Ziegler (2019), and Gutsche & Zwergel (2020), as well as on the work by Bassen et al. (2019) along two main dimensions: firstly, our design allows us to investigate potential nudging effects of and the interplay between different types of sustainability information (i.e., amount, content and framing of information) that go beyond a binary label differentiation (investment products with and without an ecolabel). Secondly, we investigate

[2] In this paper, we define preferences as an individual ordering of alternatives and regard them as endogenous (Mattauch & Hepburn, 2016).

[3] DCEs typically put participants in multiple hypothetical choice situations in which they are asked to make choices between two or more alternatives, which are characterized by attributes with alternating attribute levels between the choice alternatives. While approaches of this type, commonly referred to as stated preference techniques, are frequently put into question regarding their purely hypothetical character, discrete choice experiments enable researchers to investigate individual preferences and willingness-to-pay (WTP) for non-market or non-marketable goods, which is why they are particularly popular in health care, marketing, transport and environmental research (Bassen et al., 2019; Gutsche & Ziegler, 2019; Lagerkvist et al., 2020).

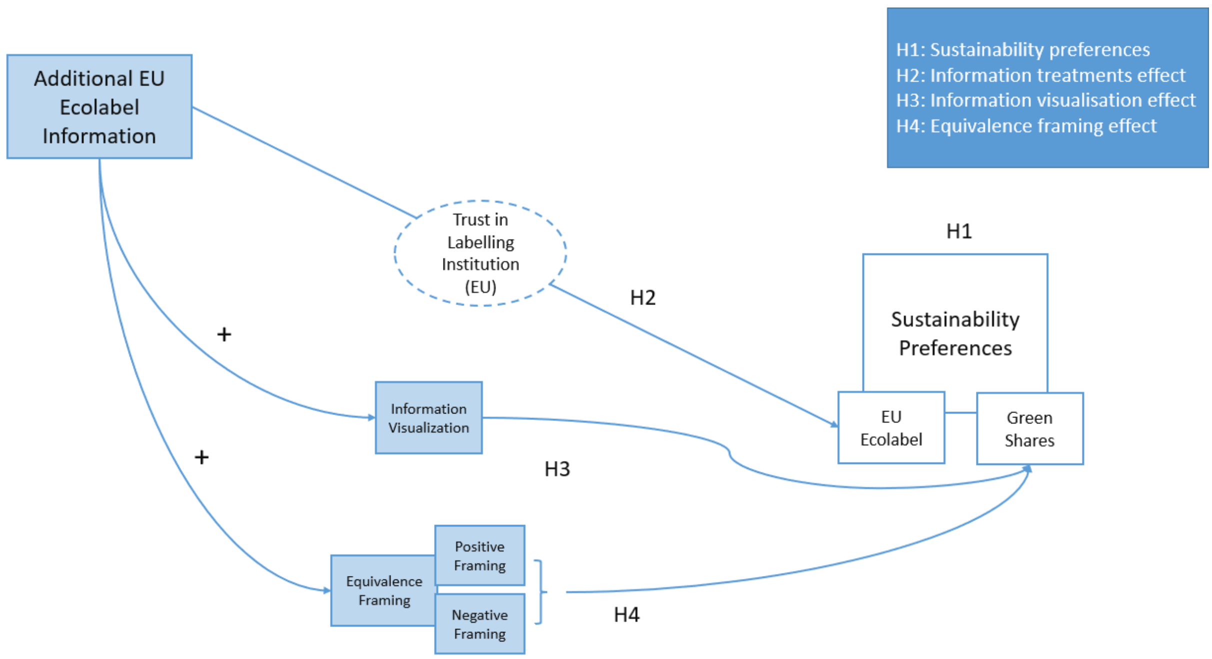
preferences for a sustainability label that is actually planned to be implemented, allowing us to draw more realistically applicable implications from our study. All of the aforementioned studies depict sustainability certifications only in generic graphical or text-description form without reference to labels that are present in the sustainable finance marketplace. The findings of this paper thus provide novel evidence on the effects of framing, information visualization, and motivational nudging on investors' preferences, while attempting to confirm the general preference for sustainability certifications reported in the related literature.

We find that treating subjects with added informational content and motivational messages accompanying the EU Ecolabel has a significant and positive effect on preferences for the label. However, results from the additional analysis suggest that this is driven more by the visual prominence of the introduced treatment rather than its informational content itself. Interestingly, we also observe that increasing the visual prominence of the fund sustainability performance conveyed in an attribute distinct from the EU Ecolabel, has a significant and positive effect on preferences for the EU Ecolabel but not on the intended attribute itself. This indicates that retail investor sustainability preferences seem to be rather affected by the overall visual prominence of the displayed sustainability information within the choice environment than by actual informational content, a notion which is also supported by our finding that retail investors appear to be prone to framing biases based on visual cues.

2.2. Literature Review and Hypotheses

The following subchapters provide short reviews of academic literature on sustainability preferences and how these can potentially be affected by information provision, more intuitive visual presentations of such information, and/or alternative information frames. We use this literature to inform our respective hypotheses. An accompanying conceptual illustration of how we expect the above-mentioned factors to influence sustainability preferences is provided in Figure 2.1.

Figure 2.1 – Conceptual Framework Including Hypotheses on the Relationship between Sustainability Preferences and Sustainable Investment Choices



Note: This conceptual framework summarizes our experimental approach in combination with the expected effects, which are formulated in the hypotheses listed in this chapter (see also in the dark blue box). The boxes shaded in light blue represent the introduced experimental treatment variations, while the white boxes represent what we expect to be affected by the treatments, respectively.

2.2.1. Sustainability Preferences

Investors are faced with a limited budget and market opportunities, and financial-driven investors' decisions are driven by the expectations of and preferences for financial returns (Antonides & van der Sar, 1990). For sustainable investors, the sustainability objective plays a role in addition to the financial objectives (Joliet & Titova, 2018). In economics, individual orderings of this type are typically referred to as preferences. How individual investors order the different objectives concerning their personal importance is an essential driver of sustainable investment decisions.

Using DCE methodology, previous studies show that sustainability preferences do seem to play an important role in investment choices: Certified sustainable funds are generally preferred over uncertified ones (see e.g., Gutsche & Ziegler, 2019), and there is an overall positive influence of climate labeling on retail investors' preferences for climate-friendly investing (Bassen et al., 2019). In particular, environmental sustainability is preferred over governance and social factors of ESG funds (Lagerkvist et al., 2020). Funds certified as sustainable are even more preferred if the certification is issued by the state and not an NGO (Gutsche & Zwergel, 2020). As indicated by the top linking arrow depicted in Figure 2.1, the first group of hypotheses reflects our intention to confirm if sustainability preferences also play a role in investment choices in the more specific context of the EU Ecolabel for retail financial products:

Hypothesis 1.A (H1.A): *Retail investors prefer EU ecolabel-certified funds over uncertified ones.*

Hypothesis 1.B (H1.B): *Retail investors prefer funds with higher shares of sustainable assets over funds with lower shares of sustainable assets.*

2.2.2. Information Provision

Information plays an important role in affecting decision-making and behavior (Amatulli et al., 2019; Cheng et al., 2011; van de Velde et al., 2010). Additional information, as well as changes in informational content, can have a nudging effect to motivate individuals toward more sustainable behavioral patterns (Lehner et al., 2016; Momsen & Stoerk, 2014; Pilaj, 2017; Thaler & Sunstein, 2008). In addition to that, trust has been shown to be an important factor in influencing consumers' behavioral intentions (Liang et al., 2019). Previous evidence shows that trust in the EU organic ecolabel is mediated by institutional trust in the EU (Gorton et al., 2021). Along these lines, distrust in label providers can act as a hindrance to sustainable investment decisions (Gutsche & Zwergel, 2020). We regard gaining a better understanding of this triangular interdependence between information and trust concerns, as well as the increasing importance of sustainability performance in financial decision-making, as crucial to enhance the efficiency and topicality of sustainability labeling endeavors in the landscape of financial investments.

As depicted in Figure 2.1, our second hypothesis revolves around the notion of sustainability information having a magnifying effect on the link between sustainability preferences and sustainable investment decision-making. Our argument here follows the notion regarding sustainability preferences as endogenous, i.e., they fall under the category of preferences that cannot be taken as given but can be altered by external influencing factors (Bowles, 1998; Mattauch & Hepburn, 2016). Previous contributions differentiate between either the sustainability certification's visual design (Bassen et al., 2019), the types of issuing entities of the sustainability labels (Gutsche & Ziegler, 2019), or the different focus in the sustainability dimensions (Lagerkvist et al., 2020), but none of them varies between the sustainability informational content. To address this research gap and to address the aforementioned interplay between information and trust, we add pro-environmental motivational messages and trust-generating information (referring to the label's EU taxonomy regulation compliance) to accompany the label in a between-subject experimental design. Based on the above considerations, we postulate the following hypotheses for confirmation:

Hypothesis 2 (H2): *Adding motivational and trust-generating information to accompany the EU Ecolabel increases retail investors' preferences for the EU ecolabel-certified funds.*

2.2.3. Information Visualization

Information visualization makes use of human visual abilities to extract meaning from information presented in a graphical manner (Fekete & Plaisant, 1999). For instance, traffic light labels that inform consumers about food safety change consumer purchase behavior by focusing their attention on specific attributes of the products (Drescher et al., 2014). To date, there is little research on how the graphical presentation of sustainability information relating to financial products affects investment decisions. A previous study demonstrates that varying the visual mode of how an investment product's sustainability performance is presented to the respondents alters hypothetical investment decisions (Bassen et al., 2019). Nevertheless, the effect of information visualization may not always be significant – an experiment on consumer preferences for graphical energy labels suggests that the effectiveness of symbolic labels is optimal in relatively simple decision environments (Verplanken & Weenig, 1993). An open question, therefore, remains if these effects can be replicated if an altered visualization is intended to convey more specific and thus complex information on a fund's sustainability. To add to the existing literature on the potential effects of graphic and prominently displayed sustainability information on retail investor preferences, we formulate the following hypothesis for confirmation:

Hypothesis 3 (H3): *Preferences for funds with higher sustainable asset shares increase if the information concerning these shares is illustrated in a graphic instead of a purely numeric manner.*

2.2.4. Equivalence Framing

Preference orders depend critically on how different prospects are framed (Tversky & Kahneman, 1986). A particular choice can be framed in different ways. Even if two types of information that can be used to inform or motivate a choice can be equivalent in content or numeric value, changes in the information's framing – from here on referred to as equivalence framing - can cause significant shifts in preferences (Chong & Druckman, 2007; Tversky & Kahneman, 1986). For instance, the rescaling of refrigerator energy labels in the EU alone shifted the consumers' stated willingness to pay (Faure et al., 2021). In the paper at hand, we are interested in the potential prevalence of framing effects related to sustainable financial products. Previous literature on framing effects has almost exclusively focused on risk perceptions and pure financial decisions (see e.g., Diacon & Hasseldine, 2007; Kumar & Sonya, 2008; Seo et al., 2010 & van der Heijden et al., 2012). Ecolabel-related literature focuses on nudging, positive framework, and graphical framing (Bassen et al., 2019; Gutsche & Zwergel, 2020), whereas our main interest is the application of different frames on more specific sustainability information related to equity funds, in our case the shares of assets with sustainable activities within the fund. To study the equivalence framing effect of sustainable share information of funds related to labels, we formulate the following hypothesis for confirmation:

Hypothesis 4 (H4): *Facing sustainability information under an equivalence frame, investors prefer funds with an overall sustainable asset share that visually appears larger, even if the number of options to the same overall level.*

2.3. Methodology

To test our hypotheses, we analyze data from an online experiment on the discrete choice between investments in different equity funds. Each fund is characterized by several attributes with attribute levels varying between the selectable options.[4]

2.3.1. Sampling Approach

Potential participants of our experiment were pre-screened according to the following criteria: They were required to currently reside in an EU country, to be at least 18 years of age, fluent in English, and feature a minimum of 95% submission approval rate on the *Prolific* platform, which we employed to recruit participants.[5] In contrast to related studies in our field of research (Bassen et al., 2019; Gutsche & Ziegler, 2019; Lagerkvist et al., 2020), we opted not to pre-screen our participants with regard to the financial experience or the role of the participants in their respective households. We chose to sample more generally because one of the goals of the EU Ecolabel is to achieve a standardized and credible sustainability signal, thereby also intending to make it easier for first-time investors to make informed decisions. Thus, our study is less oriented towards learning about the sustainability preferences of people

[4] The final study was pre-registered on OSD registries on September 1st, 2021, shortly after pre-testing the experimental survey (https://osf.io/j6adr).
[5] In cases of obvious misconduct (e.g., evidently rushing through the survey or giving nonsense answers), Prolific allows survey submissions to be rejected. The number of approved submissions per respondent is indicated by their individual submission approval rate.

already accustomed to making financial investment decisions, but more to shed light on potential design considerations behind an ecolabel that is catered to a broader audience, also including potential retail investors who might be new to investment activities but are characterized by a general increase in awareness about environmental and sustainability issues (Flammer, 2012). We accounted for this specific target audience in our experimental design, e.g., by sticking to basic financial terms accompanied by easily understandable and elaborate information that can be retrieved at all points of the survey. and relatively low hypothetical investment figures to not put participants with little financial experience or low income off right away. All participants were paid a fixed rate of GBP 1.80 and the average survey completion time was 13:53 minutes. From our main survey, we collected 1,508 complete observations on which we base our analysis. The DCE and the accompanying survey were programmed on *SoSci*.

2.3.2. Discrete Choice Experiment Design

We generated our experimental design for the DCE using the *Ngene* software package, following the criterion of minimizing the standard errors between parameter estimates, i.e., finding a design with a minimized D-error (Rose et al., 2008),[6] which ultimately resulted in a total of 36 different choice cards, of which eight were randomly displayed to our survey participants. After the introductory statement to our survey and a short identifying question, respondents were immediately confronted with contextual information on our DCE. The participants were informed that they were about to respond to a total of eight choice situations between three equity funds each and that they were supposed to choose between the funds based on a monthly investment of 50€ over a total timeframe of ten years (see Appendix A.B for the exact wording of the entire survey).

Notably, respondents were informed right away that while they would be required to choose in all eight situations to progress in the survey, they would also be granted an option to indicate that they would actually have preferred to select none of the options.[7] After the respondents were informed that they would be able to retrieve the information on all equity fund attributes at any time during all choice situations by clicking on an information dialogue button and that the funds were identical with regards

[6] Efficient designs are generally preferred over the previously common orthogonal designs because they allow researchers to acquire more precise parameter estimates (Bliemer & Rose, 2011). The d-efficient experimental design was generated on the basis of parameter priors generated in an online pre-test study with n=250 observations, which was conducted in August 2021. Due to a lack of reliable parameter priors for our specific attributes in the related literature, we opted to generate an orthogonal experimental design for the pre-test and use the parameter estimates acquired from this study for the generation of the efficient design. All attributes and levels were specified exactly as displayed in Table 2.1, with the exception that the annual fund management fee and historical average return attributes only featured three different levels (the lowest, middle, and highest level respectively). This was based on the circumstance that *Ngene* was not able to find an orthogonal design with five levels for these two attributes.

[7] We opted for this design option in order to maximize the amount of stated preference decisions. Going for this approach allows us to still collect stated information from such respondents which would actually prefer to invest in none of these options, irrespective of what reason they might have. We account for this differentiation by running a multitude of robustness checks in the analysis presented in chapter 2.4 of the paper at hand.

to all characteristics apart from the attributes displayed in our experiment, they were confronted with information on these attributes, as well as one example choice card.[8] The attributes along with the exact information used in our online survey and the levels between which each attribute varied between choice options are displayed in Table 2.1, while an example choice card is given in Figure 2.2.

The three equity funds in each choice situation were characterized by the following five attributes:

- Annual fund management fees
- Historical average annual returns (last 10 years)
- Risk classification
- EU Ecolabel
- Fund assets invested in green shares

The first two attributes are monetary, of which at least one is typically included in choice experiments to enable researchers to derive WTP estimates (Risa et al., 2011), where the annual fund management fees ranged between 0.01% and 2% p.a., while the historical average return attribute ranged between 4% and 16%. While we can derive WTP estimates based on both of these attributes, we will be relying on the annual fund management fees for the main analysis presented in this paper due to the high degree of uncertainty that is associated with inferring future from past returns (Gutsche & Ziegler, 2019). Next to the historical returns, we opted to include risk classification as a second attribute related to the financial performance of the equity funds because we regard this group of indicators as particularly important and prominent factors both in retail investors' decision-making processes (Virlics, 2013) and how equity funds are presented in real-world purchasing situations. We also did not want the financial indicators to be underrepresented compared to the sustainability attributes to keep the choice situations within our experiment as realistic as possible and similar to real financial fund products, at least regarding balancing the presented attributes.

The *EU Ecolabel* and the *Fund Assets Invested in Green Shares* attributes[9] and the respondents' preferences for/against them are the main focus of the study at hand. They are the focal point of all hypotheses discussed and presented in chapter 2.2. While the EU Ecolabel itself only varies between two levels (label; no label), we opted to have the minimum fund assets invested in green shares attribute vary between three levels, which take the form of minimum percentage values ranging between 7.5% and 12.5%. The range of these values might seem relatively low at first glance but is in fact based on realistic assessment figures (Hessenius et al., 2020). Another reason for choosing a relatively low range of percentage shares is rooted in our experimental design, in that we wanted to create a relatively stark contrast between displaying the shares in a numerical way and alternative means of illustration to test

[8] The *SoSci* platform also enables us to access detailed information on the amount of time respondents spent on each page of the survey as well as how frequently they have clicked on the information dialogue buttons.
[9] Here, "Green" refers to economic activities that are environmentally sustainable.

for equivalence framing effects as previously outlined in chapter 2.2.[10] In the subsequent chapter, both sustainability attributes and their respective modulations between experimental treatment groups will be discussed in more detail.

After being introduced to all DCE attributes and the according to levels and before progressing to the actual DCE itself, survey respondents were confronted with a cheap talk script (Penn & Hu, 2019) (see Appendix A.B, at the end of the experimental instructions). Such scripts are a well-established means to mitigate hypothetical bias in stated preference studies: They directly confront respondents with the problem of hypothetical bias in studies of this type, thereby trying to mitigate the issue and reminding respondents to answer as realistically as possible (Hensher, 2010). Finally, respondents were asked to answer a total of four multiple-choice questions to check for their understanding of the experimental procedure itself, the attributes, and the levels. In case a respondent answered at least one of these questions wrongly, or indicated not knowing the answer, they were guided to an additional information page, which was preluded by short information about their wrong or missing answer, as well as a friendly reminder to go through the information again. [11]

[10] As outlined in chapter 2.3.3, these shares are depicted via pie charts in two of our experimental treatment groups, where the pie chart illustration do not show the overall fund green shares, but the share of fund assets invested in companies with certain percentages of green turnover. Multiplied with the percentage information on the sustainability performance of these companies, we achieved identical overall percentage values as described above (ranging from 7.5% to 12.5%). However, the indirect calculation allowed us to show larger pie chart shares. Thus, there is a stark contrast between numerical and graphical (pie chart) appeal.

[11] Along with the information about the time respondents spent on the experimental information page, we use information about these wrong or missing answers to generate an additional indicator variable to differentiate between attentive and inattentive respondents, which we also use to run a number of robustness checks in our empirical analysis.

Table 2.1 – DCE Attributes, Information and Levels

Attribute:	**Information:**	**Levels:**
Annual fund management fees	**Annual fund management fees** are the yearly costs charged for the fund's management. Passively and actively managed funds have average annual fee levels of 0.2% and 1.2%, respectively.	0.01%, 0.5%, 1%, 1.5%, 2%
Historical average annual returns (last 10 years)	**Historical average annual returns (last 10 years)** are the historical average annual return calculated based on the fund performance in the past 10 years.	4%, 7%, 10%, 13%, 16%
Risk classification	**Risk classification** measures how much the fund's return varied historically, where a higher number indicates a higher risk. Risk categories 5, 6 & 7 have a historical volatility of 10%-15%, 15%-25% and >25% respectively.	Category 5 (historical volatility 10-15%) Category 6 (historical volatility 15-25%) Category 7 (historical volatility above 25%)
EU Ecolabel	**The EU Ecolabel** is an EU-wide sustainability label. In general, an **Ecolabel** is a type of sustainability performance certification. In this case, it is based on the **EU taxonomy for sustainable activities**. The final report on the EU taxonomy can be found on the European Commission website. While the taxonomy group considers fund assets invested in green shares as one criterion for granting the EU Ecolabel, they also apply specific sustainability criteria (e.g., minimum social safeguards and screening criteria) to the remaining, non-green fund assets.	Binary (Label, No Label)
Fund assets invested in green shares	**Fund assets invested in green shares** indicates the minimum percentage of the fund invested in green economic activities of the underlying company equities. Note that this attribute does not indicate anything about the sustainability of the non-green shares.	at least 7.5% at least 10% at least 12.5%

Figure 2.2 – Example Choice Card (Control Group)

	Fund 1	**Fund 2**	**Fund 3**
Annual fund management fees	2 %	1 %	0.01 %
Historical average annual returns (last 10 years)	16 %	7 %	7 %
Risk classification	7	6	5
EU Ecolabel	-	-	
Fund assets invested in green shares	at least 7.5 %	at least 10 %	at least 12.5 %

*Note***:** Example choice cards from the other four experimental groups are displayed in Appendix A.C.

2.3.3. Experimental Treatments

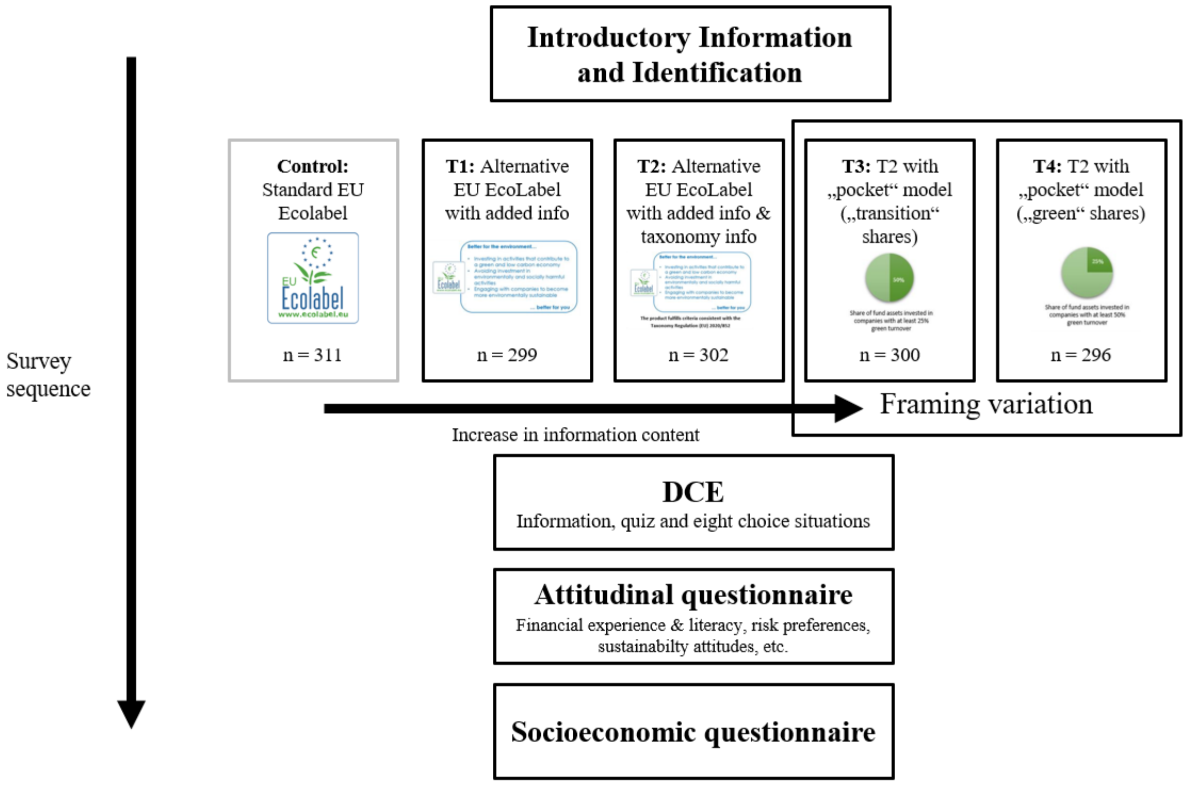
To test hypotheses *H2, H3,* and *H4*, we allocated the respondents into a total of five different experimental groups (one control and four treatment groups) in a between-subject design. As indicated in Figure 2.3, survey participants were randomly assigned to one of the groups right before they were confronted with contextual information on the DCE.[12] In the control group (henceforth group C), the *EU Ecolabel* attribute was illustrated without additional contextual information. At the same time, the *Fund Assets Invested in Green Shares* attribute was given as percentage figures without any additional highlighting, as seen in Figure 2.3.

In the first two treatment groups (henceforth groups T1 or T2 respectively), we altered the information content attached to the *EU Ecolabel*, while keeping the *Fund Assets Invested in Green Shares* attribute the same as in group C. As displayed in Appendix A.C (Additional example choice cards), participants in group T1 were confronted with an alternative version of the EU Ecolabel, in line with actual design considerations from the working group at the EC. In group T2, the same representation was enhanced with an additional note, informing the respondents about the respective equity fund fulfilling criteria consistent with the EU taxonomy. To test hypothesis H2, we compare respondent preferences for the

[12] This means that the example choice card shown to respondents on the choice experiment introduction page was already in line with the attribute design of the participants' respective treatment group.

EU Ecolabel observed in each of the first two treatment groups with those observed in group C, as well as between treatment groups T2 and T1 respectively. In the third and fourth treatment groups (henceforth groups T3 or T4 respectively), we kept the depiction of the *EU Ecolabel* attribute constant (in line with the representation in group T2), while altering the visual appearance of the percentage shares within the *Fund Assets Invested in the Green Shares* attribute. As illustrated on the respective example choice cards in Appendix A.C, we opted to go for a pie chart design to increase the visual prominence of the related attribute, while employing two different versions of the so-called "pocket" approach considered by the EC working group.[13]

Figure 2.3 – Survey sequence with experimental treatment variation



[13] In outlining the assessment criteria for fund sustainability, the EC working group at one point considered the "pocket" approach, which essentially classified companies into different "pockets" based on the percentage share of revenues a respective company derives from green activities, i.e., activities that are in line with the EU taxonomy. Using this approach was still considered in June 2020 in the early design stages of the study presented in this paper but has since been shelved as it was regarded as too restrictive for asset and portfolio managers. However, we still regarded it as an interesting basis for our mechanism to test hypothesis *H4* and thus opted to keep the differentiation as part of our choice experiment.

In group T3, the pie chart provides information on the percentage share of the fund assets invested in companies with at least 25% green turnover, which are categorized as "transition" companies by the EC working group. In group T4, we went for the same design but this time indicating fund assets invested in companies with at least 50% green turnover ("green" companies). This design choice fulfills two purposes: firstly, it enables us to test hypothesis *H3*, as both groups T3 and T4 are confronted with quantitatively equal information on the fund assets invested in green shares, same as for the first three experimental groups, but only in a more graphically intuitive manner.[14] Secondly, we exploit the two different company classifications ("transition" and "green") along with the "pocket" approach to alternate the percentages displayed on the pie charts, thereby making the green shares presented in group T3 visually appear to be more positive from a sustainability point of view, while remaining mathematically equal to the ones displayed to respondents in group T4. We compare the combined preferences for the *Fund Assets Invested in Green Shares* attribute from groups T3 and T4 with the preferences from the remainder of the sample to test hypothesis *H3*. To test hypothesis *H4*, we compare preferences for the same attribute between groups T3 and T4.

2.3.4. Variables

Throughout the econometric analysis, outlined in more detail in chapter 2.4 of the paper at hand, the dependent variable is a dummy variable reflecting respondents' choice for one of the three alternative equity funds in each choice set. Our main explanatory variables reflect the choice attributes as discussed above in subchapters 2.3.2 and 2.3.3. We treat the management fees p.a. and historical average returns p.a. as continuous variables, while the other three attributes (risk classification, EU Ecolabel, and fund assets) are coded as discrete variables, i.e., we generate dummy variables for each level of the respective attribute. We use the highest risk class (class 7), no EU Ecolabel, as well as the lowest percentage of fund assets invested in green shares as base categories respectively.[15] We additionally code treatment dummies for the experimental groups described in subchapter 2.3.3 and interact them with attribute variables to test hypotheses *H2* and *H3*. Finally, we employ a set of additional socioeconomic control variables, as well as a set of explanatory variables based on attitudinal scales collected during the survey to see if the influence of these variables on retail investor preferences can corroborate findings from similar studies, as well as to test for potential heterogeneous treatment effects. Descriptive statistics on these variables are given in Table 2.2.

[14] In both groups T3 and T4, the pie chart percentages multiplied with the respective company green turnover shares result in the exact same overall green shares than in group C, T1 and T2, again ranging from 7.5% to 12.5% overall.

[15] Dummy variables for base categories are not included in the models to avoid perfect multicollinearity.

Table 2.2 – Descriptive Statistics on Additional Control and Explanatory Variables

VARIABLES	n	Mean	SD	Min	Max
Gender (female = 0; male = 1)	1,492	0.505	0.500	0	1
Age (in years)	1,500	25.70	7.641	18	96
High education (no university degree = 0; university degree = 1)	1,508	0.521	0.500	0	1
Income class	1,296	4.962	2.970	1	12
Risk index	1,497	-0.460	1.143	-3	3
Financial experience (no experience = 0; > 0 years of experience = 1)[16]	1,508	0.482	0.500	0	1
Generalized trust index	1,501	0.038	1.164	-3	3
Institutional trust index	1,473	0.298	1.103	-3	3
Patience	1,506	1.341	1.140	-3	3
Altruism	1,506	0.969	1.285	-3	3
Ecological political orientation	1,460	1.224	1.395	-3	3
New Environmental Paradigm index	1,487	0.496	1.230	-3	3

Note: The questions forming the basis for all variables can be retrieved from Appendix A.B. The risk index is an average calculated based on three items (Cronbach's alpha = 0.48) from the DOSPERT scale (Weber & Blais, 2006) where higher values indicate a higher propensity towards engaging in risky behavior. The generalized trust index is an average based on three items (Cronbach's alpha = 0.72) from the interpersonal trust short scale (Nießen et al., 2020). The institutional trust index is an average based on four items (Cronbach's alpha = 0.84) on trust in the EU institutions taken from two different sources (Gorton et al., 2021; Love et al., 2013). The patience and altruism variables are based on single Likert-scale items, as is the variable measuring ecological political orientation. Finally, the New Environmental Paradigm index is an average of two items (Cronbach's alpha = 0.35) selected from the New Environmental Paradigm scale (Dunlap & Van Liere, 1978).

2.4. Analysis

2.4.1. Econometric Approach

The empirical analysis presented in this paper is based on the data collected from the online DCE described in chapter 2.3. Each respondent i was faced with $M = 8$ choice situations in which they were asked to state their preference for one of $J = 3$ different equity funds characterized by the attributes as listed and described in Table 2.1. Following related literature, we base our econometric analysis to investigate the effect of these attributes on the choice between the different hypothetical equity funds on multinomial discrete choice models (Gutsche & Ziegler, 2019). To investigate potential experimental treatment effects, as well as potential effects of the additional explanatory and control variables listed in Table 2.2, we employ interaction terms between these variables and the variables on the equity fund

[16] As can be seen in the survey (Appendix A.B), the answers to the financial experience question were categories indicating different number of years of financial experience. However, only 10% of respondents indicated to have more than three years of financial experience, so we opted to recode the variable to a dummy indicating any financial experience. Throughout our analysis, we ran alternative specifications including the original variable specification, however the results did not change with regards to sign or statistical significance.

attributes. For our main results, we choose to use the simulated maximum likelihood estimation of mixed logit models (Hensher & Greene, 2003; Mcfadden & Train, 2000) over common multinomial logit models because they do not rely on the restrictive and often inadequate independence of irrelevant alternatives property (Hoyos, 2010) and their ability to incorporate unobserved correlation, i.e., between alternatives in a choice set. In line with the practice established in related studies (Goett et al., 2000; Hensher et al., 2005), we specify these interaction terms and the parameters associated with financial attributes (Management Fees, Historical Returns, and Risk Classification) as fixed, whereas the non-financial attributes (EU Ecolabel, Medium Green Shares, High Green Shares) are specified as random parameters. Caused by the simulation aspect of our estimation approach, we also report the estimated standard deviations for the random parameters next to mean estimates in all our result tables.

We present all our main results in the following manner: The result tables presented in-text depict the outcomes of mixed logit model estimations in the WTP space using the user-written Stata command *mixlogitwtp* (Hole, 2016). Instead of deriving WTP estimates based on coefficient ratios that are estimated in the preference space, this approach specifies the WTP distributions already at the estimation stage. The differences in model fit between mixed logit estimations in the preference space and WTP has been shown to be marginal, while the outcomes of WTP space estimations lead to more conservative WTP estimates and more easily comprehensible coefficients that can be interpreted directly (Hole & Kolstad, 2012). All WTP coefficients are calculated based in terms of the fund management fee attribute. Additionally, for all in-text result tables, we report the outcomes of identically specified mixed logit models in the preference space in the Appendix.[17]

2.4.2. Results and Discussion

Overall Respondent Preferences

Table 2.3 presents the parameter estimates with robust standard errors, as well as the standard deviations of the random parameters with standard errors. These estimates refer to the choice between three hypothetical equity funds across the total sample. The first column shows estimates from the simulated maximum likelihood estimation based on our full set of observations, i.e., N = 1,508 individual observations.[18] Model estimates given in Table 2.3's columns (2) – (4) are alternative sample specifications, in which we gradually exclude different combinations of observations from respondents who either indicated that they would prefer to choose none of the equity funds presented to them in a given choice situation and/or observations in which respondents failed to answer the DCE quiz correctly

[17] Throughout our analysis, we employ the user-written Stata commands *mixlogitwtp* (Hole, 2016) and *mixlogit* (Hole, 2007) for WTP space and preference space estimations respectively and we use R = 1000 Halton draws for the simulated approximation of the choice probabilities between the alternatives in a given choice set.

[18] The number of observations given in all tables refers to the number of respondents multiplied with the number of choice situations per respondent times the number of alternatives in each choice situation (e.g., for the full sample 1,508*8*3 = 36,192).

and/or just clicked through the DCE information.[19] We report these alternative specifications to provide robustness checks. We trade off sample size for a stricter sampling of observations (i.e., specification (4) in Table 2.3 represents the most restrictive estimation since all observations of the aforementioned two types are excluded).

We observe that the parameter estimates for almost all attributes have the expected signs, which are highly significant across different sample specifications. The notable exception here is the parameter estimate indicating preferences for medium green shares (10%) over the lowest category of green shares (7.5%), which maintains its negative direction throughout all four specifications given in Table 2.3. As previously explained, our estimated coefficients can be directly interpreted as WTP in terms of annual management fees while they obviously should be regarded with caution due to the purely hypothetical nature of these estimates. Still, we can observe that the average respondent stated a relatively strong WTP for equity funds that feature the EU Ecolabel (ranging between 1.51 and 1.77 percentage points of annual fund management fees depending on the sample specification).

[Result 1.A]: *Retail investors do prefer EU ecolabel-certified funds over uncertified ones.*

Contrasting the strong preferences for sustainability in choosing between equity funds are the relatively low WTP estimates for the highest amount of fund assets invested in green shares (between 0.25 and 0.3 percentage points of fund management fees). Among the financial indicator attributes, the average respondent also stated a high preference for less risky funds, as indicated by the large WTP estimates for the lowest risk class over the highest one. In combination with the relatively high percentages of respondents who are willing to forego an increase in historical average returns of a fund (between 0.31 and 0.33 percentage points of annual fund management fees for one additional percent of historical average returns), this illustrates the strong preference for more traditional financial performance indicators within our sample.

[Result 1.B]: *Respondents show a stronger preference for the EU ecolabel than for more fund assets invested in green shares. In general, we do not find consistent evidence that funds with higher shares of green assets are preferred over funds with lower shares of green assets.*

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[19] As indicated earlier, using the SoSci survey software enables us to track the time respondents spent on specific pages of the survey. We classified those observations as 'Rushers' who spent less than 60 seconds on the page where we displayed detailed information on the DCE itself, as well as the hypothetical equity funds and their attributes.

In sum, these findings align with the general trend identified in related studies published in recent years: (Potential) retail investors state sizeable and robust preferences for labels certified as sustainable (Bassen et al., 2019; Gutsche & Ziegler, 2019; Gutsche & Zwergel, 2020). Our results are especially comparable to the choice experiment results reported by (Gutsche & Zwergel, 2020) and the second experiment presented by (Gutsche & Ziegler, 2019), which both used a similar set of attributes, albeit with larger annual management/subscription fees, explaining the somewhat smaller WTP figures for the sustainability indicator, i.e., the EU Ecolabel. Our study adds to these results by focusing on a specific and more realistically illustrated label issued by a well-known organization, thereby confirming that general preferences for sustainability signals among financial products also hold if they are directly issued by and associated with an international governmental entity that for some might generate additional trust towards the label, while for others it might be tainted with negative connotations.[20]

[20] All four of the cited studies opted to go for more generic nomenclature and descriptions with regards to the sustainability certification included in their respective DCE.

Table 2.3 – Main DCE Results in WTP Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters
Management fees	-0.678***	0.850***	-0.452***	1.082***	-0.470***	0.792***	-0.198	1.064***
	(0.050)	(0.049)	(0.057)	(0.069)	(0.053)	(0.055)	(0.000)	(0.054)
EU Ecolabel	1.771***	1.920***	1.746***	1.852***	1.507***	1.635***	1.506***	1.671***
	(0.087)	(0.105)	(0.084)	(0.097)	(0.084)	(0.103)	(0.099)	(0.152)
Medium green shares	-0.734***	2.136***	-0.628***	2.053***	-0.875***	2.062***	-0.807***	2.010***
	(0.177)	(0.177)	(0.176)	(0.127)	(0.192)	(0.170)	(0.204)	(0.181)
High green shares	0.304***	0.812***	0.323***	0.897***	0.251***	0.528***	0.261***	0.659***
	(0.061)	(0.111)	(0.064)	(0.067)	(0.062)	(0.136)	(0.064)	(0.224)
Historical returns	0.330***		0.320***		0.319***		0.309***	
	(0.014)		(0.015)		(0.015)		(0.017)	
Medium risk class	1.312***		1.344***		1.304***		1.275***	
	(0.112)		(0.113)		(0.119)		(0.138)	
Low-risk class	2.982***		3.020***		2.898***		2.979***	
	(0.101)		(0.105)		(0.099)		(0.097)	
Sample	Full	Full	Full	Full	Full	Full	Full	Full
Observations	36,192	36,192	27,393	27,393	25,512	25,512	19,269	19,269
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in WTP space. Estimation results given in this table are based on eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. ‘No choice’ refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. ‘Rushers’ refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page. Outcomes of an identically specified model in the preference space are given in Appendix Table A.A1.

Information Treatment Effects

In Table 2.4, we show parameter estimates from three models, which differ regarding the sample subsets their respective estimates are based on. While the estimates shown in column (1) of Table 2.4 are based only on respondents that were randomly allocated to the control group (C) or the first treatment group (T1), column (2) only includes observations from groups C and T2 and column (3) from groups T1 and T2. In each of the three models, we included interaction terms between all previously introduced attribute variables (except the main cost variable, and the annual fund management fees) and dummy variables where a positive value indicates membership in the treatment group relevant to the specific sample specification. We use this approach to investigate potential treatment effects caused by the information treatment as specified in subchapter 2.3.3.

The parameter estimates given in column (1) provide information on the effect of the added information presented on the EU Ecolabel (T1) when compared to the control group (C). As in Table 2.3, we see that the effects of all attribute variables on the choice between three equity funds except the medium green share dummy have the expected sign. However, we also observe that the random parameter estimates regarding the variable referring to the high share of fund assets invested in green shares loses statistical significance compared to the models given in Table 2.3.[21]

In line with our hypothesis on the effect of the information added to the EU Ecolabel, we observe that the interaction term between the EU Ecolabel and the T1 dummy variable has a positive and significant effect on the equity fund choice. This effect is robust across different sample specifications and estimation methods (see Appendix Tables A.A2 and A.A5) and the WTP is relatively large at 0.69 percentage points of added annual management fees that the average treated respondent would be willing to pay over an average control group respondent. Additionally, we observe a positive, significant, and robust effect (see alternative specifications in Table A.A2) of the first treatment (motivational information) on preferences for the fund's historical average returns, indicating that the information added to the EU Ecolabel also has the potential to affect other attributes.

[21] The models we show in Table 2.3 are based on the full sample, which naturally increases the likelihood of finding statistically significant effects and also include observations from groups T3 and T4, where more visual emphasis was put on the fund assets invested in green shares attribute.

Table 2.4 – Information Treatment Effects in WTP Space

	(1) Interaction with T1		(2) Interaction with T2		(3) Interaction with T2	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.647***	0.841***	-0.732***	1.014***	-0.729***	0.929***
	(0.077)	(0.079)	(0.086)	(0.086)	(0.086)	(0.081)
EU Ecolabel * Treat	0.686***		1.077***		0.438	
	(0.246)		(0.288)		(0.279)	
Medium green shares * Treat	0.167		0.699*		0.434	
	(0.402)		(0.406)		(0.455)	
High green shares * Treat	0.274		0.477**		0.057	
	(0.174)		(0.196)		(0.189)	
Historical returns * Treat	0.108***		0.222***		0.104**	
	(0.042)		(0.048)		(0.047)	
Medium risk class * Treat	0.301		1.307***		0.991***	
	(0.312)		(0.366)		(0.380)	
Low risk class * Treat	0.049		0.737***		0.681***	
	(0.189)		(0.230)		(0.223)	
EU Ecolabel	1.068***	1.889***	1.081***	2.017***	1.790***	2.099***
	(0.164)	(0.158)	(0.207)	(0.184)	(0.197)	(0.186)
Medium green shares	-1.161***	2.311***	-1.315***	2.392***	-1.116***	2.334***
	(0.338)	(0.241)	(0.362)	(0.273)	(0.398)	(0.250)
High green shares	0.072	0.683***	0.060	0.556**	0.314**	0.671***
	(0.122)	(0.145)	(0.132)	(0.216)	(0.134)	(0.188)
Historical returns	0.203***		0.196***		0.310***	
	(0.029)		(0.032)		(0.033)	
Medium risk class	0.928***		0.943***		1.234***	
	(0.203)		(0.229)		(0.265)	
Low risk class	2.799***		2.917***		3.016***	
	(0.175)		(0.191)		(0.199)	
Sample	T1 & C	T1 & C	T2 & C	T2 & C	T2 & T1	T2 & T1
Observations	14,640	14,640	14,712	14,712	14,424	14,424
'No Choice' included	YES	YES	YES	YES	YES	YES
'Rushers' included	YES	YES	YES	YES	YES	YES

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page. Alternative sample specifications for all three models reported in this table can be found in Appendix Tables A.A2 - A.A4, and identically specified models estimated in the preference space can be found in Appendix Tables A.A5 - A.A7.

The prevalence of this phenomenon becomes even more apparent when looking at the parameter estimates in column (2) of Table 2.4, which we use to investigate the effect of the second information treatment (trust-generating information - added EU taxonomy note below the EU Ecolabel information box) on the WTP for the different DCE attributes. Here, we observe an even stronger treatment effect on the average WTP for funds being certified with the EU Ecolabel, this time sitting at 1.10 percentage points of added WTP in terms of annual fund management fees when compared to the control group. However, in this subset of the experimental sample, we observe positive, significant, sizable, and robust treatment effects not only on the historical annual returns attribute but on all attribute-based variables included in the model. However, not all of these findings are robust to alternative specifications, which holds especially for the EU Ecolabel, and both green share attributes (see Appendix Table A.A3).

Column (3) in Table 2.4 indicates that the added effect of the EU taxonomy note (T2) to the basic information treatment (T1) has no statistically significant effect on either the EU Ecolabel preferences or preferences for any of the two green share attributes. While the positive and significant WTP estimates for both attributes indicating lower risk classes remain significant throughout alternative sample and model specifications, this does not hold for the estimate relating to the historical returns.

To further investigate the overall effect of the information treatments, we take an additional look at a group of models in which we pool respondents allocated to treatment groups T1 and T2. Appendix Table A.A8 confirms the patterns we observe in models (1) and (2) of Table 2.4, where the added information treatment has a positive effect on EU Ecolabel preferences that is both statistically and economically significant throughout different sample specifications (added WTP in terms of annual fund management fees over group C respondents ranges between 0.723 to 0.862 percentage points). Again, we also observe a consistently positive and significant effect of the information added to the EU Ecolabel on other attributes such as the historical average annual returns and preferences for lower risk classes of the equity funds. Interestingly, the treatments have an insignificant but positive average effect on the medium fund assets invested in green shares attribute, whose parameter estimate maintains its counterintuitive negative sign outside the treatment groups T1 & T2. A potential interpretation of the treatments having a positive effect on attributes other than the EU Ecolabel itself could be that the more prominent visual appearance and its informational contents on average triggered a more in-depth involvement of respondents with the subject matter at hand, which would also explain the positive and intuitive treatment effects on preferences for the fund assets invested in green shares.

[Result 2]: *Added motivational information on the EU ecolabel has a significant and positive effect on respondent preferences for the EU Ecolabel. However, we do not find robust evidence for an added effect from the further inclusion of the trust-generating information.*

These results corroborate prior evidence on additional, specifically motivational, information attached to labels increasing consumer preferences (Bjørner et al., 2004), where such information acts as a sort of "cheap talk" signal. The lack of an additional effect of the second treatment (trust-generating information) might be attributed to different factors: One straightforward explanation would be that, in line with findings from Newell & Siikamäki (2015) who employ a DCE on energy efficiency labeling, that simple information seems to have a stronger effect on sustainable decision-making than more technical and complex information. This finding could also be related to issues of consumer information overload (Jacoby, 1984). Another explanation of course could be the weakness of the information brought forward in the second treatment itself. Firstly, it does not convey relevant information to respondents that were not previously displayed on the experimental introduction pages anyway. Thus, it seems reasonable to assume that for attentive participants, the information on the choice cards was not of any additional value in the first place. While more inattentive participants might have asked themselves what the EU taxonomy was during the DCE, our data shows that participants in group T2 did not retrieve the label-related info significantly more often than those in group T1 (Mann-Whitney U-Test: $p = 0.786$). We could still reasonably expect the added info in T2 to have an additional effect on label preferences via its visual prominence alone, however, especially in comparison to the information introduced in group T1, the added information in T2 is of negligible visual prominence. The final point of discussion in this section refers to the multitude of treatment effects on preferences for unintended attribute levels, specifically catering to the effects observed in model (2) of Table 2.4. It seems that attaching additional information to the EU Ecolabel and thereby introducing additional information for respondents to evaluate within the DCE overall, tends to positively affect preferences, especially for attributes related to the financial performance of the fund in question, specifically the funds' historical returns. Here, a potential explanation could be that the added information leads to additional deliberation, ultimately causing respondents to be willing to pay additional fund fees for an improved fund performance across the board.

Information Visualization Effects

The treatments we introduced in treatment groups T3 and T4 regard visual prominence and accessibility of the sustainability information as the main driver of potential treatment effects. The estimates in Table 2.5 are derived from a total of four models, the first based on the full set of observations (i.e., the control plus all treatment groups), while the others exclude observations according to the criteria established above. To investigate the combined effect of the treatments in groups T3 and T4, i.e., the alternative pie-chart representation of the fund assets invested in green shares attribute, we included interaction terms between a dummy indicator for belonging to these treatment groups and the established attribute variables. We observe that illustrating the fund assets invested in green shares as pie charts does not seem to have any effect on average preferences for either of the two relevant attributes. While the parameter estimates of the respective interaction terms have the intuitive direction across all model specifications, they remain statistically insignificant throughout. Again, however, we do observe that the pie-chart illustration has a statistically significant and positive effect on average preferences for both the historical average returns, as well as for the EU Ecolabel. However, the magnitude of the treatment effect on the EU Ecolabel as expressed in WTP does not appear all too high, ranging only between 0.35 and 0.40 percentage points in terms of annual fund management fees.

[Result 3]: *We find no evidence that presenting the green fund asset shares in a graphical manner increases investors' preferences for a fund with higher green shares. However, we find that this mode of presentation seems to have a positive effect on preferences for the EU Ecolabel.*

At first glance, this result contradicts findings from previous studies which were able to show that high visibility and easily comprehensible information on or associated with sustainability labels positively affects consumer preferences for such certifications (Donato & Adıgüzel, 2022) and can even produce stronger stated sustainability preferences than binary certifications (Bassen et al., 2019). Additional previous research shows that the use of scales enhanced with color (Ní Choisdealbha & Lunn, 2020) or well-known reference symbols as e.g., traffic lights (Drescher et al., 2014) are preferred over plain text information. Our analysis shows that the alternative pie chart representation of the fund assets invested in green shares on the choice cards did not have the hypothesized significant effect on respondent preferences for higher levels of this attribute while causing a positive effect on EU Ecolabel and historical return preferences. This unintended treatment effect delivers a potential explanation for the lack of the expected treatment effect: As brought forward in related literature, sustainability labels themselves fulfill the purpose of conveying complex information in a simple way, thereby enabling consumers to make sustainable decisions if they wish to do so (Bjørner et al., 2004). At the same time however, confronting a consumer with too much information on the sustainability performance of the product in question might make it difficult to extract the relevant information (Sasaki et al., 2011), while constraints related to time or cognitive capabilities might lead to the information being ignored altogether (Dörnyei & Gyulavári, 2016). While our actual reasoning behind the pie chart representation of the fund assets invested in green shares was to make the sustainability information more prominent and easily comprehensible, it might have triggered an alternative mechanism more in line with the literature cited above: The added complexity of the choice decision that was introduced with the pie charts (two percentage figures instead of one in groups C, T1 & T2), could have outweighed the visual prominence and intuitive graphical representation via the pie charts. Despite this, while people might have neglected the specific information brought forward by the pie chart illustrations, the added visual prominence might have strengthened the overall concern for sustainability within the choice environment, causing respondents to issue stronger preferences for the EU Ecolabel. Along similar lines, we also have to take into consideration that the approach of using two separate sustainability indicator attributes in our experiment might have caused a certain degree of confusion among respondents, which could also explain the overall weak results concerning higher fund assets invested in green shares attribute. While we took efforts to explain that both attributes function independently from each other in our experimental introductions, many respondents opted to issue their sustainability preferences mainly by choosing funds certified with the EU Ecolabel, which provides an interesting insight into how different types of sustainability information within a choice environment interact.[22]

[22] However, we would like to point out that we find no strong evidence for such problems within our data. While some respondents commented on the overall complexity of the subject matter, no one pointed out specific issues related to the green share attributes, or any attributes for that matter.

Table 2.5 – Effects of Information Visualization Treatment in WTP Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.675***	0.856***	-0.450***	1.091***	-0.465***	0.797***	-0.184***	1.076***
	(0.050)	(0.049)	(0.057)	(0.070)	(0.053)	(0.054)	(0.068)	(0.081)
EU Ecolabel * Pie	0.396**		0.371**		0.384**		0.348**	
	(0.166)		(0.160)		(0.168)		(0.160)	
Med. green shares * Pie	0.259		0.488*		0.143		0.386	
	(0.282)		(0.259)		(0.300)		(0.300)	
High green shares * Pie	0.166		0.148		0.040		0.085	
	(0.123)		(0.121)		(0.121)		(0.124)	
Historical returns * Pie	0.074***		0.051*		0.073**		0.053*	
	(0.028)		(0.029)		(0.030)		(0.030)	
Medium risk class * Pie	-0.124		-0.188		-0.230		-0.267	
	(0.225)		(0.232)		(0.241)		(0.258)	
Low risk class * Pie	-0.159		-0.150		-0.223*		-0.276**	
	(0.129)		(0.133)		(0.132)		(0.137)	
EU Ecolabel	1.622***	1.916***	1.609***	1.865***	1.348***	1.624***	1.355***	1.667***
	(0.105)	(0.106)	(0.111)	(0.100)	(0.107)	(0.102)	(0.103)	(0.106)
Medium green shares	-0.832***	2.125***	-0.817***	2.061***	-0.931***	2.074***	-0.928***	1.957***
	(0.207)	(0.173)	(0.218)	(0.123)	(0.220)	(0.160)	(0.243)	(0.170)
High green shares	0.241***	0.809***	0.257***	0.865***	0.241***	0.515***	0.236***	0.595***
	(0.078)	(0.114)	(0.083)	(0.069)	(0.078)	(0.139)	(0.080)	(0.107)
Historical returns	0.302***		0.301***		0.291***		0.287***	
	(0.018)		(0.019)		(0.019)		(0.018)	
Medium risk class	1.370***		1.437***		1.405***		1.415***	
	(0.142)		(0.153)		(0.153)		(0.174)	
Low risk class	3.044***		3.087***		2.986***		3.071***	
	(0.115)		(0.122)		(0.115)		(0.128)	
Sample	Full	Full	Full	Full	Full	Full	Full	Full
Observations	36,192	36,192	27,393	27,393	25,512	25,512	19,269	19,269
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interactions with treatment dummies indicating a respondent's assignment to one of the two relevant treatment groups (Pie: T3 or T4). Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page. Identically specified models estimated in the preference space can be found in Appendix Table A.A9.

Equivalence Framing Effects

Table 2.6 provides information on the parameter estimates from four mixed logit estimations in the WTP space, which we ran to investigate the potential effects of our final treatment, i.e., the equivalence framing of the information on the equity funds' assets invested in green shares. For this purpose, we restrict our sample to only include observations from the final two treatment groups T3 and T4, and include interaction terms between a dummy variable indicating being allocated to treatment group T3 and the variables indicating the known fund attribute levels.[23] Looking at the parameter estimates of the interaction between the T3 dummy and the high fund asset invested in green shares indicator variable, we observe a relatively small but positive treatment effect (WTP ranging between 0.19 and 0.36 percentage points as expressed in annual fund management fees), which is however not robust with regards to statistical significance throughout our alternative sample specifications. While the average effect of the equivalence framing treatment on preferences for the medium fund assets invested in green shares is positive throughout all four alternative specifications shown in Table 2.6, it fails to reach conventional levels of statistical significance.

The equivalence framing treatment also appears to have somewhat of a similar effect to that of the pie-chart representation of the fund assets invested in green shares attribute on preferences for the EU Ecolabel, as observed in Table 2.5. We only observe this effect in the models presented in columns (3) and (4) of Table 2.6 however, indicating that its magnitude seems to increase with more restrictive sample specifications. In fact, the average respondent treated with the positive equivalence framing treatment features a positive WTP ranging between 0.42 and 0.66 percentage points (referring only to significant effects in models (3) and (4)) as expressed in annual fund management fees over respondents exposed to the identical but alternatively framed information.

[Result 4]: *We find suggestive evidence that retail investors prefer funds with an overall green asset share that visually appears larger even though the visually smaller one represents the same overall green asset share.*

Taking our somewhat inconclusive finding on the positive effect of positively framed sustainability information on sustainability preferences at face value would align with the findings brought forward in previous literature (van de Velde et al., 2010), while the overall evidence on framing effects in nudging

[23] We hypothesized preferences for the fund assets invested in green shares attribute to increase with a more positive framing. For the sake of simplicity in interpreting the presented effects, we therefore opted to show interactions with the dummy for treatment group T3 over the base category T4, as the shares were presented more positively in T3.

pro-environmental behavior remains mixed (Ní Choisdealbha & Lunn, 2020) or even yields results contrary to economic intuition (Amatulli et al., 2019). In the context of our study, the treatment effect of the positive equivalence framing we do observe is likely dampened by the weak reaction towards changes in the fund assets invested in green shares attribute overall. Potential reasons for this have been discussed in the previous subchapter.

Table 2.6 – Effects of Framing Treatment Estimated in WTP Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.640***	0.764***	-0.391***	0.895***	-0.424***	0.673***	-0.135	0.841***
	(0.075)	(0.072)	(0.083)	(0.098)	(0.080)	(0.080)	(0.093)	(0.109)
EU Ecolabel * T3	-0.074		0.155		0.418*		0.655**	
	(0.251)		(0.255)		(0.249)		(0.261)	
Med. green shares * T3	0.189		0.229		0.301		0.346	
	(0.412)		(0.415)		(0.446)		(0.443)	
High green shares * T3	0.267		0.360*		0.188		0.330*	
	(0.191)		(0.196)		(0.180)		(0.190)	
Historical returns * T3	-0.003		0.033		0.039		0.100**	
	(0.044)		(0.045)		(0.044)		(0.046)	
Medium risk class * T3	-0.130		0.216		0.152		0.656*	
	(0.346)		(0.352)		(0.354)		(0.366)	
Low risk class * T3	-0.392**		-0.355*		-0.277		-0.169	
	(0.196)		(0.207)		(0.193)		(0.203)	
EU Ecolabel	2.024***	1.759***	1.842***	1.709***	1.483***	1.533***	1.367***	1.565***
	(0.189)	(0.157)	(0.178)	(0.163)	(0.180)	(0.145)	(0.175)	(0.147)
Medium green shares	-0.503	1.956***	-0.177	1.519***	-0.641*	1.807***	-0.341	1.408***
	(0.335)	(0.231)	(0.321)	(0.160)	(0.359)	(0.349)	(0.361)	(0.189)
High green shares	0.254*	0.855***	0.289**	0.934***	0.203	0.516**	0.194	0.646***
	(0.137)	(0.169)	(0.135)	(0.131)	(0.129)	(0.203)	(0.135)	(0.175)
Historical returns	0.376***		0.339***		0.342***		0.300***	
	(0.031)		(0.030)		(0.031)		(0.031)	
Medium risk class	1.311***		1.149***		1.087***		0.840***	
	(0.254)		(0.249)		(0.256)		(0.254)	
Low risk class	3.008***		2.948***		2.797***		2.762***	
	(0.185)		(0.183)		(0.176)		(0.173)	
Sample	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4
Observations	14,304	14,304	10,818	10,818	9,984	9,984	7,530	7,530
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interactions with treatment dummies indicating a respondent's assignment to the relevant treatment group (T3). Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page. Identically specified models estimated in the preference space can be found in Appendix Table A.A10.

Preference Heterogeneity Between Investor Groups

The majority of our results presented in Table 2.7 align with findings from previous literature. Especially the link between stated preferences for sustainability indicators and related political affiliations appears to be robust over different experimental contexts, as this effect is also pronounced and robust throughout different analyses in Gutsche & Ziegler (2019). Unlike Gutsche & Ziegler (2019), we did not collect a direct indicator variable for warm glow feelings stemming from sustainable investments, which the authors identify as a strong predictor for considering sustainability criteria in a hypothetical investment environment. Still, the closest proxy to this phenomenon based on the question phrasing would be our altruism indicator, which is also a robust predictor of positive preferences for the EU Ecolabel throughout all our specifications. We are also able to provide positive supporting evidence to the author's findings regarding the negative relationship between higher education and preferences for sustainability indicators. Turning toward other publications, we do find suggestive evidence for a negative relationship between financial experience and increased preferences for sustainability certifications. This somewhat contrasts with the findings reported by Lagerkvist et al. (2020), who do not identify any relationship of this type. We are also able to provide contrasting evidence to the notion that investment decisions concerning sustainability are mostly driven by behavioral features and not socioeconomic characteristics (Lagerkvist et al., 2020), as we can present strong evidence for gender heterogeneity regarding preferences for the EU Ecolabel.

[Result 5]: *We find robust evidence that the female gender, belonging to a lower income class, a higher stated altruism index, as well as identification with ecological politics, are positively associated with higher preferences for EU eco-labeled funds. We additionally find mixed evidence that a younger age, lower financial experience, as well as a higher institutional trust towards the EU is associated with stronger preferences for the EU Ecolabel while holding a university degree is associated with a decrease of these preferences.*

Table 2.7 – Interaction Terms with Socioeconomic Indicator and Scale Indices Estimated in the WTP Space

VARIABLES	(1) Ecolabel interaction	Standard deviations	(2) High green share interaction	Standard deviations	(3) Historical returns interaction	Standard deviations	(4) Low risk class interaction	Standard deviations
Management fees	-0.679***	0.831***	-0.665***	0.823***	-0.660***	0.849***	-0.634***	0.717***
	(0.056)	(0.052)	(0.056)	(0.054)	(0.056)	(0.052)	(0.054)	(0.054)
Gender interaction	-0.576***		-0.065		0.122***		0.317**	
	(0.160)		(0.128)		(0.022)		(0.126)	
Age interaction	-0.025***		-0.004		0.002		-0.001	
	(0.010)		(0.008)		(0.001)		(0.008)	
Education interaction	-0.509***		-0.192		-0.015		0.169	
	(0.154)		(0.126)		(0.021)		(0.126)	
Income class interaction	-0.072***		-0.005		0.006*		0.010	
	(0.025)		(0.020)		(0.003)		(0.021)	
Risk index interaction	0.053		0.049		-0.001		-0.300***	
	(0.064)		(0.054)		(0.009)		(0.057)	
Financial exp. interaction	-0.231		0.047		0.095***		-0.305**	
	(0.150)		(0.127)		(0.022)		(0.129)	
Gen. trust interaction	-0.172***		0.050		0.029***		-0.145***	
	(0.062)		(0.053)		(0.009)		(0.054)	
Inst. trust interaction	0.130*		0.072		-0.010		-0.000	
	(0.070)		(0.057)		(0.009)		(0.060)	
Patience interaction	-0.092		0.008		0.007		0.125**	
	(0.066)		(0.055)		(0.009)		(0.059)	
Altruism interaction	0.202***		0.040		-0.018**		-0.012	
	(0.059)		(0.048)		(0.008)		(0.048)	
Ecol. Politics interaction	0.420***		0.120***		-0.029***		-0.063	
	(0.059)		(0.046)		(0.008)		(0.047)	
NEP interaction	0.065		0.048		-0.002		0.077	
	(0.063)		(0.051)		(0.009)		(0.051)	
EU Ecolabel	2.866***	1.647***	1.769***	1.885***	1.787***	1.782***	1.752***	1.873***
	(0.332)	(0.109)	(0.095)	(0.116)	(0.094)	(0.110)	(0.093)	(0.116)
Medium green shares	-0.957***	2.411***	-0.907***	2.393***	-0.793***	2.149***	-0.814***	2.353***
	(0.212)	(0.164)	(0.208)	(0.188)	(0.199)	(0.168)	(0.198)	(0.179)
High green shares	0.319***	0.765***	0.366	0.767***	0.356***	0.750***	0.315***	0.871***
	(0.067)	(0.123)	(0.267)	(0.127)	(0.067)	(0.126)	(0.068)	(0.110)
Historical returns	0.335***		0.324***		0.199***		0.336***	
	(0.015)		(0.016)		(0.045)		(0.015)	
Medium risk class	1.324***		1.415***		1.319***		1.278***	
	(0.124)		(0.124)		(0.126)		(0.122)	
Low risk class	3.059***		3.062***		3.047***		2.591***	
	(0.117)		(0.119)		(0.115)		(0.278)	
Sample	Full	Full	Full	Full	Full	Full	Full	Full
Observations	29,136	29,136	29,136	29,136	29,136	29,136	29,136	29,136
'No Choice' included	YES	YES	YES	YES	YES	YES	YES	YES
'Rushers' included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and interaction terms between a dummy indicator for the equity fund attribute indicated in the column heading. The socioeconomic control and additional explanatory variables are listed and explained in Table 2.2. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page. Estimates of identically specified models based on alternative sample specifications are given in Appendix Tables A.A11- A.A14. Estimates of identically specified models estimated in the preference space are given in Tables A.A15 - A.A18.

2.5. Concluding Remarks

In the context of the ongoing development of a standardized EU ecolabel for financial products, our study aims to shed light on how potential retail investors respond to specific information accompanying such an ecolabel in either text or graphical form. While we can confirm overall positive preferences for sustainability labels among retail investors in the context of our study, the results of our experiment provide evidence that both salience treatments in the form of added information, motivational messages, and the corresponding higher visual prominence, lead to an immediate increase in potential retail investor preferences for funds with such certifications. We also observe that more intuitively displayed sustainability information on quantitative scales appears to perform much less efficiently in affecting investor preferences, while the added prominence of the sustainability information induced by this treatment appears to have a spillover effect on preferences for the more intuitive and clear-cut sustainability indicator, which is the EU Ecolabel. We can also confirm that potential retail investors are subject to specific framing biases. In conclusion, our results confirm previous evidence on label preferences by underlining that simpler means of information display, as well as relatively straightforward information attached to the labels, apparently function more effectively in guiding investors to more sustainable investment decisions than more complex ways of presentation characterized by sophisticated information. Thereby, our findings add to the growing body of literature on the role of individual behavioral patterns and biases in sustainable investment decision-making.

Next to their theoretical and methodological contribution, the findings of this study have several implications for policymakers in sustainable finance. Our results suggest that the quality rigidity of a financial ecolabel itself is a crucial factor for achieving sustainable impact: We underline that potential retail investors make decisions based on heuristics and visual cues even if more sophisticated information becomes available, which implies that they may be susceptible to greenwashing. Nevertheless, it also suggests that the sustainability preferences of potential retail investors can relatively easily be triggered and that ecolabels can be a useful policy tool in directing investors towards more sustainable investments. Therefore, the labeling criteria and procedures are important safeguards to ensure the sustainability of financial products. Moreover, the implementation of the EU Ecolabel may take the findings on behavioral responses in this research into consideration, both when designing labels and when considering addressing specific behavioral barriers in sustainable retail investment decisions.

Our study also points out several important areas for future research. First, our study bases the experiment on actual EU Ecolabel design considerations with data collected from EU countries and, for the sake of a clean experimental design that is aimed at answering specific research questions related to informational framing effects, we opted to exclude other types of labels next to the EU Ecolabel. Future empirical work could further investigate potential preference heterogeneity between governmental certifications like the EU Ecolabel and other third-party ecolabels. Secondly, while our paper did share some light on the differences among individuals from different EU countries, we did not cater our design towards this specifically, and future studies could investigate in more detail how such cultural and political heterogeneity may play a role in affecting ecolabel preferences in the financial market. Finally, once more government-backed financial sustainability labels such as the EU Ecolabel are released into the market, future studies could rely on real incentives related to investment decisions and conduct field experiments to study how findings from studies focusing on stated preference techniques differ from those measuring revealed preferences of retail investors. In this manner, we could learn more about potential systematic differences between hypothetical and incentivized studies in this field, which would ultimately benefit both researchers and policymakers in enabling a more effective knowledge transfer from academic studies to markets.

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Chapter 3 - The ‘Fetters of the Sib’ in an Uncertain Business Environment - An Experimental Study in Burkina Faso

by

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Abstract: We conducted a field experiment in Burkina Faso to investigate the impact of informal sharing obligations within kin networks on entrepreneurial effort. Tailors were incentivized to produce bags and our treatment intervention was to subtly inform tailors’ families about this income opportunity. We expected that informing the family should lead to an average decrease in entrepreneurial effort. However, the overall treatment effect we find is insignificant and the observed effect even points in the opposite direction than expected. Ex-post explorative analysis motivated by previous research findings, reveals that average effects mask differences regarding how tailors adjusted their production processes. Heterogeneity in working longer hours vs. asking additional people for help between the two treatment groups highlights the importance of reciprocity norms and income hiding. Additionally, we show how some tailors in the treatment group were able to utilize their kin network to their joint advantage, underlining the positive potential of kin networks in an uncertain business environment.

Keywords: Field experiment, Redistributive pressure, Social norms, Sharing norms, Kinship tax, Business development

3.1. Introduction

Informal sharing obligations, oftentimes also referred to as redistributive pressure or kinship tax, imposed by extended family and social networks have been identified as a potentially detrimental factor hampering the growth of small businesses in low-income countries (Alby et al., 2020; Di Falco & Bulte, 2011; Fafchamps, 2004; Grimm et al., 2013; Hoff & Sen, 2006; Platteau, 2000). Such kin networks can provide individuals with social insurance or financial credit when formal access is either unavailable or unaffordable (Coate & Ravallion, 1993; Jakiela & Ozier, 2016). However, the redistributive pressure, i.e., sharing expectations of less successful network members (Rosenzweig, 1988), is often argued to have potentially negative effects on entrepreneurial incentives, thereby impeding investments and small-business development (Alger & Weibull, 2010; Grimm et al., 2017; Squires, 2017). This pressure, figuratively coined by Max Weber as the 'fetters of the sib', has historically been regarded as an impediment to socioeconomic development (as cited in Alger & Weibull, 2010). Supporting this notion, recent survey-based (Baland et al., 2011, 2016; Di Falco & Bulte, 2011, 2013) and experimental studies (Ashraf, 2009; Bulte et al., 2018; di Falco et al., 2018; Dupas & Robinson, 2013; Fiala, 2017) document that redistributive pressure within kin networks can induce evasive behavior, e.g., hiding experimental payoffs from the network, which even goes as far as individuals spending money right away (Goldberg, 2017), or being willing to pay a sizeable financial premium to keep novel income sources secret (Beekman et al., 2015; Boltz et al., 2019; Di Falco et al., 2019; Jakiela & Ozier, 2016). These studies, although related to network pressure from the family, follow the general idea introduced in Dana et al. (2007), in that experimental subjects can escape perceived pressure to behave in a pro-social manner.

In natural business environments, however, it can be difficult to hide income from the kin network as many small- to medium-sized businesses in low-income countries employ family members and money is often kept in cash instead of a bank account. If hiding is difficult and people are reluctant to share, entrepreneurs might instead choose to work less hard, especially in cases where kinship taxation is collected on basis of the generated income rather than in form of fixed transfers. Thus, kin networks might dampen entrepreneurial activity when individual work effort is negatively affected by the prospect of sharing norms. This phenomenon has been examined both in survey-based work (Grimm et al., 2013) and lab-in-the-field experiments (Alger et al., 2020). Our study contributes to this strand of literature by presenting results from a field experiment with tailors in Burkina Faso, which was implemented in a natural business environment. The tailors participating in our experiment were financially incentivized to work on a real effort task, similar to their regular business activity, over the course of one day: the production of standardized bags from recycled materials. To determine the effect of sharing norms on entrepreneurial activity, our experimental treatment varied whether a member of the tailor's family was informed about the lucrative income opportunity (treatment group) or not (control group). Thereby, we were able to manipulate tailors' opportunities to hide potential experimental payoffs from their kin network.

Our main hypothesis was that tailors in the control group would generate a higher average productive output when compared to those in the treatment group. This is because control group tailors would have a higher incentive to input more effort into the lucrative business opportunity provided by our experimental setting, as they would not have to fear immediate redistributive pressure from their kin network. Our study thus provides new insights into this specific strand of literature in two key and novel ways: firstly, we can observe the potential effects of redistributive pressure on entrepreneurial effort in a natural business environment, instead of effort tasks carried out in lab-in-the-field settings. Our treatment intervention also aims at subtly activating informal sharing norms by informing the family network instead of explicitly enabling income-hiding behavior among the experimental subjects. Secondly, we can identify the adaptation strategies of entrepreneurs under controlled conditions. Compared to a laboratory setting, entrepreneurs in our sample had more time to respond to the offer and the potential sharing demands from their kin networks allowing them to choose from a broader set of strategies to adjust their mode of production and circumvent potential problems in order to maximize the experimental payoff. Compared to alternative econometric approaches, e.g., using panel data, we are able to observe tailors under ceteris paribus conditions regarding one specific task and we were able to induce exogenous variation relating to the potential activation of sharing norms, thereby increasing the internal validity of our findings. The choice of our methodology, however, comes at the expense of a relatively small sample size due to strict selection criteria and therefore a lack of representativeness for the overall population of tailors.

We find a null treatment effect: Whether a tailor's social network was informed about the income opportunity or not does not affect how many bags are produced on average. Additionally conducted explorative analysis however indicates interesting heterogeneity related to the tailors' financial family ties and the family's tradition in tailoring, highlighting the potential role of reciprocity norms distinct from redistributive pressure (Baland et al., 2016). There are also interesting differences between both experimental groups regarding the labor used to fulfill the experimental work order: Relative to the control group, tailors in the treatment group were more likely to have other people helping them fulfill the order, while tailors in the control group were more likely to invest high personal effort (stating that they have worked the whole night) when compared to the treatment group. While the control group's higher tendency of working the whole night relative to the control group production process could be interpreted as consistent with previous findings on evasive behavior in the absence of informal sharing obligations, our results suggest that if the information on additional income opportunities is made public within the kin network, entrepreneurs can indeed exhibit a positive reaction towards sharing norms. They in fact seem able to use the kin network to their joint advantage by integrating its members and their expertise into the production process, thereby offsetting potential gains from evasive responses. We also find that some of the variation in bag output can be attributed to self-reported 'problems' faced by the tailors, such as lack of electricity during the production process: When tailors reported having faced such a problem, treatment group tailors were able to produce significantly more bags than those in the control group. The combination of these findings is consistent with the idea that networks help provide insurance in uncertain business environments – while your relatives might tax you, they will also provide help in case you need it.

3.2. Experimental Design and Sampling Approach

To investigate the causal effect of informal sharing norms on entrepreneurial effort, we implemented a multi-staged field experiment in January 2011 in Ouagadougou, Burkina Faso, where solidarity norms in family networks are known to be particularly strong (Englebert, 2018; Fiske, 1990). To acquire a sufficiently large homogenous population of small-scale entrepreneurs, we decided to sample local tailors, which represent one of the largest informal sector industries within our study population. Requiring a natural income opportunity to observe and compare the sampled tailors' exerted effort, we offered all participants the identical business opportunity to produce bags over 24 hours at a lucrative fixed piece rate of 4 US$ (2,000 Fcfa (CFA Franc)), excluding material costs that were covered by us as well. The median tailor produced six bags within 24 hours resulting in an average turnover of 12.000 Fcfa which is considerably higher than the reported median weekly business profit of tailors (7,500 Fcfa). The tailors were provided with all materials necessary to produce up to twelve bags along with one sample bag and an upfront payment of 4 US$ in case the tailor accepted the business offer.[24] Experimental variation was introduced by randomly allocating participants into two different treatment conditions, differing exclusively with regards to the triggering of informal sharing norms: in half of our experimental sample, we informed the tailors' families about the income opportunity without creating suspicion of an experiment or deceiving the participants, while in the other half, the families were left uninformed. To do so we needed several sampling stages, which we explain below.

3.2.1. Preparatory Stages

After an initial census of 631 tailors in 10 (out of 30) randomly selected districts in Ouagadougou (Stage I in Figure 3.1), we targeted 400 tailors, which were randomly selected to answer a baseline questionnaire. 386 of these tailors could be interviewed (Stage II). Importantly, this questionnaire was meant to collect detailed socioeconomic and business information about informal tailoring entrepreneurs in Ouagadougou and the tailors' business practices, of which the connections to their social network were one part (published in Grimm et al. (2017)). The information we collected during these initial interviews allows us to include specific covariates in our main regression models that allow us to isolate the potential effect of sharing norms from reciprocal obligations. As indicated above, small-scale businesses in low-income countries are often family businesses or at least are characterized by family

[24] Out of the 125 tailors participating in the final experiment, three tailors managed to produce more than twelve bags by either tailoring slightly smaller bags or buying additional material. Example photos of the provided materials and a sample bag can be found in Appendix B.B.

involvement (Jakiela & Ozier, 2016), which oftentimes includes financial support in the early stages of establishing a business. We, therefore, collected information on past financial aid and potential family traditions in the tailoring business and include them as control variables in our main regression model specifications. Yet, none of the questions explicitly foreshadowed the implementation or topic of the later experiment itself.

Based on the information collected in this survey, we were able to exclude tailors according to three main criteria: First, we excluded the few tailors who were not the actual owner of their respective tailoring businesses (n=16). We chose to do so because our experimental intervention required tailors to have quick and unambiguous decision-making power related to the production processes within the tailoring business. Secondly, we opted to exclude tailors who did not indicate to have any people within their social network (i.e., extended family, friends, and neighbors) whom they have supported financially regularly within the last year (n=49). This step was crucial for our treatment intervention to be potentially effective: Relating to the practicality of our approach, we would not have been able to implement our treatment (the network member phone calls) in cases where no network information was provided at all. Therefore, we would have needed to deceive tailors without network information, e.g., telling them that we contacted a network member (which we in fact could not do), or we could have included them in the final sample for the control group only, thereby creating selection bias which would have distorted our estimation. To implement our phone survey with the tailor's kin network members (Stage III), we also needed to exclude tailors that were unable or unwilling to provide phone contact details of at least one recipient of past financial transfers (n=129) within that network (see more detailed information below).[25] This was essential to not deceive tailors when informing them that we obtained her address from her family member. While we cannot eliminate the possibility that the tailors could have denied providing financial information on the social network, as well as its members' phone contacts for reasons that might be related to sharing norms, this would not bias our experimental treatments which, importantly, were assigned after the stage. Excluding tailors along those criteria left

[25] One might argue that this could have affected the external validity of our experiment, in that a share of tailors were potentially unwilling to forward such information based on fear of some form of redistributive pressure already. In Appendix Table B.A1a (models (3) and (4)) we present results from probit regressions to address this issue by investigating if there was any selective attrition between the subgroup of tailors that were unable or unwilling to provide contact information and those included in Stage III. We observe that the results are only marginally different from the first two models presented in Table B.A1a, suggesting that there was no selective attrition outside the one we expected based on the applied exclusion criteria. The lower coefficients for 'positive net family transfers' in models (3) and (4) can intuitively be explained by the exclusion of the subgroup of tailors that did not indicate any financial family ties at all. We thus conclude that there was no selective attrition affecting the external validity of our experiment and believe that this is due to the fact that the tailors were at no point made aware of the fact that the initial survey stood in any kind of relation to the experiment, i.e., any potential earnings associated with the research activity.

a total of 192 tailors to participate in the experiment. The exclusion of tailors naturally reduces the representativeness of our sample compared to the overall population of tailors.[26]

In stage III, participants were randomly allocated into control or treatment conditions. Afterward, we randomly identified and contacted one family member from the list of family contacts that received aid and were provided to us by the tailors during the initial survey in stage II. Within this short phone survey, the tailors' network member was asked about existing solidarity ties (one of which should have been the respective tailor from our sample) and financial relations within their kin network. The survey did not mention that it was connected to the initial survey among tailors. Naturally, some respondents refused to answer or could not be reached (e.g., wrong number, no cellphone reception, cellphone not charged, etc.). To ensure our treatment intervention remained effective, we only included such tailors in our sample (both for control and treatment to keep groups comparable) where the respective family contact unambiguously confirmed that they had regularly received money from the respective tailor in the past (i.e., we were able to clearly 'match' a tailor to the respective contact). This was done by the interviewers themselves. Out of the 192 tailors, we could retain 134 after this stage.

3.2.2. Treatment Intervention

During the phone survey, and in case the tailor was previously allocated to the treatment group, we informed the respective family contact about the business opportunity for the tailor. We used an indirect and subtle methodology of informing the network to avoid suspicion.[27] The interviewer mentioned the business opportunity in passing and asked for the tailor's phone number and address, which was only pro forma of course since we already had that information on each tailor in our sample. The exact wording that the interviewer was supposed to use at that point was as follows:

"It is interesting that you mention a tailor, a friend of mine from Europe is looking for tailors in Ouagadougou to help him perform a lucrative job offer. Could you please give me the number of your (... son, brother, nephew ...) so that I can suggest him/ her the business opportunity?"

In Stage IV, the tailors were visited and informed about the job opportunity itself. To strengthen and validate our experimental intervention, tailors in the treatment group were told that we received their

[26] Appendix Table B.A1 and the first two modesl in Table B.A1a display descriptive statisticts of tailors at this stage, as well as probit regression results on tailor characteristics affecting the probability to be excluded by our sampling criteria. The results show that tailors born in Ouagadougou are more likely to be excluded during this sampling stage, while tailors with a bank account and a history of positive financial transfers are less likely to be excluded. Additionally, two variables related to the staff of the tailoring business and two relating to the tailor's household size show small but statistically significant effects. We regard this as unproblematic as all of these factors are intuitively related to the exclusion criteria employed in this stage.

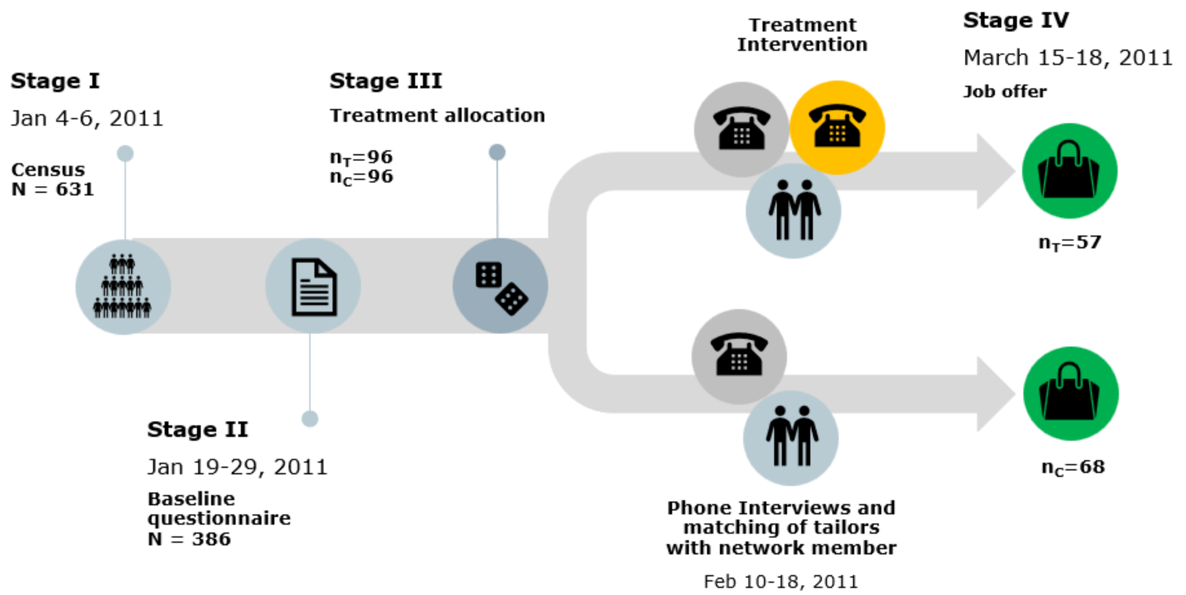
[27] One could argue that such a type of treatment intervention might be too weak to expect significant effects. However, we argue that we were faced with balancing a tradeoff between the realism of our treatment intervention and the strength of the treatment without making it too obvious in order to avoid reactance or making people aware of the experiment. This ultimately resulted in us favoring a more cautious and natural approach in order not to spoil the entire experiment.

number from someone in their family, i.e., the direct connection to the initial survey remained unknown to them, which was additionally ensured by changing enumerators between the survey and Stage IV. From this intervention, we know that all treatment group tailors were treated *directly* during the offer. Our experiment was designed to capture mainly this effect. However, there is also potential for an additional *indirect* treatment effect depending on the action taken by the network members, who might have contacted the tailor themselves in response to the phone survey. Given the setting of our experiment, we could not ask the tailors whether they were contacted by their network and thus, we are not able to clearly disentangle these two effects. While our direct treatment was intended to evoke redistributive pressure in general, the potential contact between the network member and the tailor may have also activated reciprocity norms between the tailor and the contacted network member.[28] Thus, the only difference between the treatment and control group was the information given to the 'matched' family members and the tailors themselves. Following these procedures ultimately resulted in a sample of 134 tailors out of which nine were not present at their workshop on the day of the experiment. Thus, the final sample includes 125 tailors (Stage IV). In order to avoid potential spillover effects, it was not possible to extend the experiment over several weeks and thereby increase the sample size. Our team worked simultaneously in ten different districts. Additionally, we had purchased already all available production material (used rice bags) and would have needed to wait for new material to arrive.

After the business opportunity ended and the tailors handed in the produced bags, they were casually involved in a conversation to find out about any potential problems related to the production process and to learn about how they managed to produce the bags (see Table B.A3 in the Appendix). These conversations took place in the respective tailors' workshops. We employ the information collected in these conversations in our explorative analysis presented and discussed in chapter 3.3.2.

[28] It could be argued that the family members thereby assume an active role, since they are the ones who recommend the tailor and stand at the origin of the connection to job offer. In some instances, this might have created a situation in which the tailor was put into a situation of owing something to the family member, which would provide an argument for interpreting potential treatment effects as based on reciprocity norms, rather than redistributive pressure. However, we do not want to rule out the role of redistributive pressure based on this altogether, especially as we do not consider answering a simple phone call to be necessarily able to trigger reciprocal actions.

FIGURE 3.1 – Sample Selection



3.2.3. Balance between Experimental Groups and Power Calculations

Appendix tables B.A1b through B.A2a display summary statistics and balancing tests between the treatment and control groups along with a set of socioeconomic indicator variables at two stages of the sampling process: after the initial sample selection Stage III (N = 192), and the final Stage IV (N = 125). Testing for the equality of group means reveals that they are not significantly different from each other within both stages (respective p-values from F-Tests p = 0.654 for Stage III and p = 0.636 for Stage IV). However, as the magnitude of the differences and not necessarily their statistical significance is important, we add a column with scale-invariant normalized differences according to Imbens & Wooldridge (2009) to our balance tables. In both sampling stages, only two variables relating to the tailors' level of education exceed the postulated rule of thumb normalized difference threshold of one quarter, which is why we present additional model specifications in the Appendix including these variables in our main regression Table 3.1. In Stage IV, we additionally observe an imbalance with regard to the indicator variable for a family tradition in tailoring. This variable is part of our main set of covariates, and it is thus included in all our regression models presented in this paper. Appendix table B.A2b additionally displays two probit regressions to check for selective attrition between both sampling stages. We only find that two of the control variables (belonging to the ethnic group of the Mossi and total staff) slightly increase the probability of being part of the final sample to a statistically significant degree. Overall, this reassures us that groups were balanced, and no selective attrition took place.

During the time the experiment was implemented, there were no comparable field experimental studies, and thus no comparable effect sizes to warrant a reasonable a priori power calculation. Still, to account for the relatively small sample size resulting from our selection criteria, we provide two types of ex-post analysis assessing the statistical power of our study, as well as its sensitivity. We consider di Falco et al. (2018) as the study closest to our own with regards to design and the social dynamics potentially triggered by the treatment intervention, which is why we regard the main effect reported in this study (Cohen's d = 0.28, which would equal a difference of 1.3 bags in our experiment) as a yardstick for a relevant main effect size.[29] Given the weekly business profit of 7,500 Fcfa, we deem a difference of 1.3 bags (2600 Fcfa) within 24 hours also as economically relevant. As the first part of our ex-post power analysis, in Appendix Table B.A1c we provide information on the minimum detectable effect sizes (MDE) of the effects reported in our main outcome Table 3.1, which we calculated based on Ioannidis et al. (2017). We additionally provide the inferred Cohen's d based on the standard deviation of our main outcome variable (# of bags produced) in our full experimental sample (n = 125). Based on the commonly used rule of thumb for effect sizes (Sawilowsky, 2009), we are able to detect small (d = 0.35) to medium effects (d = 0.50) with medium (50%) and high power (80%) respectively, relating to mean differences in our main outcome variable. The minimum detectable effect sizes thus range between 1.6 and 2.2 bags for the main outcome and between 3.2 and 5.7 bags for the investigated interaction effects. Specifically, all significant interaction effects we report in our main results table have high power (80%) to detect effects below the observed magnitude. Thus, we can conclude that our study is not underpowered to detect effect sizes of magnitudes similar to the ones reported in similar studies.

3.3. Results

The first two panels in Figure 3.2 show the distribution of bags produced between both experimental groups, indicating that one tailor managed to produce a total of 20 bags (by buying additional material) while a sizeable share of tailors produced no bags at all – the share of zero bag observations between the treatment and control group is not different to a statistically significant degree (Mann-Whitney U-Test: p = 0.376). On average, we find that tailors from the treatment group produced 5.91 bags during our study period and only 0.34 (5.75%) bags more than tailors in the control group. The difference is not statistically significant (Mann-Whitney U-Test: p = 0.536) and goes in the opposite direction than expected.

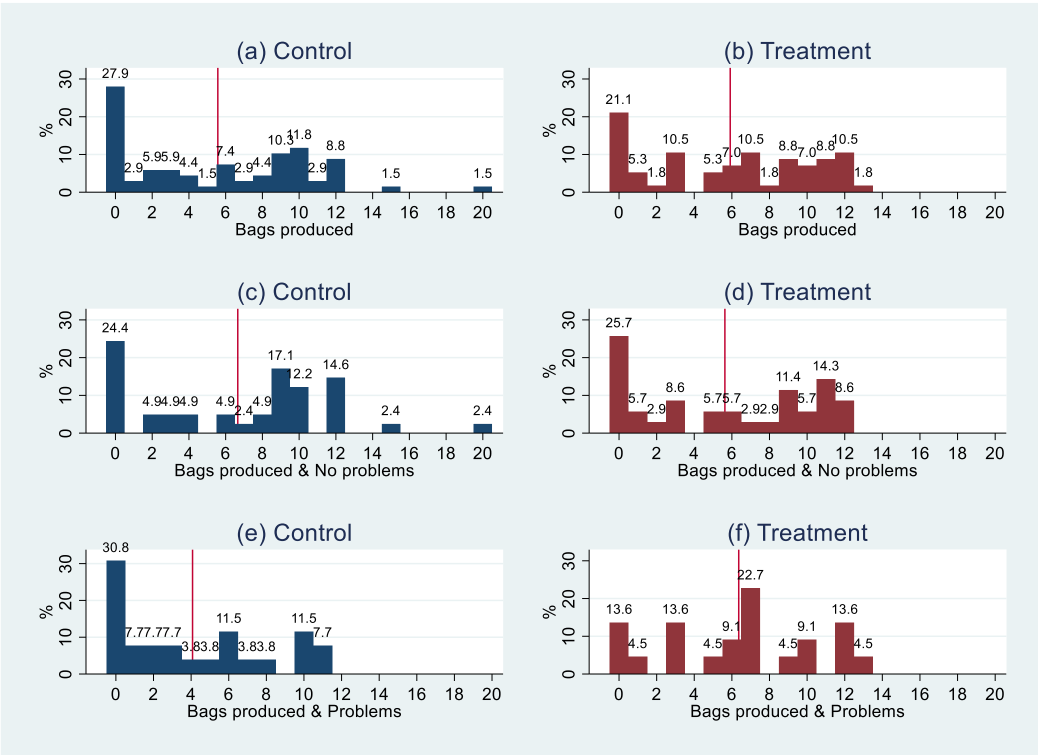
In addition to the discussion on our power to test for the presence of treatment effects by looking at the MDEs in (cf. section 3.2.3.), we also investigate the absence of a main treatment effect by performing

[29] The effect size was calculated based on the main treatment effect as reported by the unstandardized regression coefficient of -0.66 fewer discussion partners in Table 3.2, column (a) in di Falco et al. (2018) as well as the reported sample standard deviation of this variable (2.35) and the reported group sizes ($n_t = 148$ and $n_c = 166$).

multiple t-tests of mean equivalence (Lakens et al., 2020), starting with our smallest effect size of interest set at Cohen's d = 0.28 (1.3 bags), again based on the main finding reported in di Falco et al. (2018). Performing a two one-sided mean equivalence test (TOST) against equivalence bounds based on this effect size leads us to conclude that we are unable to conclusively reject effect sizes of that magnitude (p-value = 0.1265). To provide additional insight into the sensitivity of these results, the mean equivalence test becomes significant at the 10%-level when assuming equivalence bounds based on an effect size of Cohen's d = 0.31 (or 1.45 bags; p-value = 0.093) and at the 5%-level when assuming equivalence bounds equaling an effect size of d = 0.38 (1.75 bags; p-value = 0.047). Despite the relatively small sample size, we are thus able to reject small effect sizes that are only marginally larger than the ones reported in a comparable field experimental study.

Irrespective of this, we regard the observed mean difference as also economically insignificant. Thus, we turn to the analysis of heterogeneous effects showing that the experimental treatment only seems to have affected some tailors (section 3.3.1) and also that the treatment group used effective adaptation strategies, especially when encountering problems during the bag production (section 3.3.2).

Figure 3.2 – Histograms on Bag Production



Note: Frequencies (bars) and means (vertical red lines) of bag production when not treated (a) and when treated (b). Control group: n = 68; Treatment group: n = 57. Frequencies (bars) and means (vertical red lines) of bag production when not treated and reporting no problems (c: n = 41), when treated and reporting no problems (d: n = 35), when not treated and reporting problems (e: n = 26), when treated and reporting problems (f: n = 22).

3.3.1. *Heterogeneous Responses to Sharing Obligations*

The first column of Table 3.1 (without any controls) and the first two columns in Appendix Table B.4 (with additional controls and all investigated interaction terms respectively) show regression results on the main treatment effect.[30] Generally, our regression analysis confirms the finding that informing a tailor's social network about the new income opportunity has no statistically significant effect on the number of bags produced (models in columns 1 & 2 of Table 3.1). We provide several robustness checks to these estimations in the Appendix.[31]

[30] The full model specifications with additional control variables are given in Table B.A4, showing that the inclusion of those controls has only minor effects on the magnitude of our results, while not affecting their statistical significance.

[31] Tables B.A4a and B.A4b show Cragg hurdle and tobit regressions (censored at zero and twelve bags) respectively to check for the robustness of our main results. The Cragg hurdle regressions confirm that the treatment effect does not affect the average tendency to produce no bags and that there is also no treatment effect among tailors that in fact produced bags. Results from the tobit regressions generally show larger coefficients but confirm our findings in also yielding insignificant treatment effects on bag production.

Table 3.1 – Heterogeneous Effects on Sharing Obligations

VARIABLES	(1) main effect	(2) Interaction *siblings*	(3) Interaction *help*	(4) Interaction *transfer*	(5) Interaction *family staff*	(6) Interaction *tradition*	(7) Interaction *bank*
treatment (network informed)	0.339	1.754	-0.578	0.733	0.626	-0.263	2.565**
	(0.830)	(1.719)	(0.936)	(1.597)	(1.021)	(0.900)	(1.006)
no. of siblings		0.0111					
		(0.204)					
treatment x no. of siblings		-0.277					
		(0.309)					
family help received			-0.308				
			(1.314)				
treatment x family help			5.144***				
			(1.633)				
positive net family transfers				-1.317			
				(1.249)			
treatment x positive transfers				-0.371			
				(1.862)			
family members in staff					-0.222		
					(0.591)		
treatment x family staff					-0.302		
					(0.902)		
family tradition						-1.810	
						(1.280)	
treatment x family tradition						7.180***	
						(1.638)	
bank account							1.947*
							(1.173)
treatment x bank account							-4.756***
							(1.631)
control group mean	5.574***	5.574***	5.574***	5.574***	5.574***	5.574***	5.574***
Observations	125	122	125	125	125	125	125
R-squared	0.001	0.008	0.074	0.017	0.008	0.044	0.067
Additional Controls	NO	NO	NO	NO	NO	NO	NO

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Dependent variable: Bags produced - OLS regressions with robust standard errors. All models specified with additional socioeconomic controls are given in Table B.A4.

To shed light on potential mechanisms of how solidarity networks and associated norms may influence entrepreneurial effort, we expand our analysis by testing if differences in a tailor's family and financial background induce heterogeneous treatment responses.[32] Columns (2) to (6) of Table 3.1 display regression results including different interaction terms between the treatment and socioeconomic indicator variables which we, based on our review of the related literature, assume could influence how tailors might react to the treatment. We find that in our study, larger social networks, which we proxy by a participant's number of siblings to follow the approach of the related study by Grimm et al. (2017), do not affect production levels and do not interact with the treatment condition in a significant way (column 2).[33] This finding differs from the results presented, e.g., in di Falco et al. (2018). We do find, however, that having received financial aid from the family during a respective tailor enterprise's startup phase increases bag production in the treatment group (column 3), indicating the potential importance of reciprocity norms that are activated if the family network is informed about the business opportunity (Alger & Weibull, 2010; Beekman et al., 2015). One reason for the strength of this effect could potentially rest with the reciprocal relationship between the tailor and those network members contacted as part of the treatment intervention that might feel the tailor owes them for setting up the business opportunity in the first place (see also Footnote 29). Including the interaction term between the treatment indicator and past financial aid notably changes the direction of the treatment effect (while remaining insignificant), representing suggestive evidence that the treatment intervention might have induced a small evasive response when evaluating only tailors without prior family aid (the corresponding regression coefficient suggests 0.58 fewer bags produced in the treatment group on average). However, since past financial aid from the family network is controlled for in model (2) of Table B.A4, and is shown to be insignificant, we can conclude that it is in fact the effect of the interaction between the treatment and family aid which strongly increases productivity among the treated who received family aid.

We do not find evidence that being a net receiver or sender of financial aid has a significant impact on bag production (column 4).[34] While the number of family members employed within the respective tailoring business also does not seem to affect the average bag production in a significant way (column 5), a stated family tradition in tailoring businesses significantly increases bag production in the treatment group (column 6). This reinforcing influence of a knowledgeable tailor's family on bag production, in case the family has been informed, might be explained by either stronger reciprocity norms coupled with

[32] Calculations of the according minimum detectable effect sizes are given in Appendix Table B.A1c.

[33] Note that we exclude the variable indicating the tailors' number of siblings in all models but Table 3.1 - model (2) (and the corresponding model 3 in Table B.A4 and B.A4b), because its inclusion would have dropped three observations. Due to considerations related to our sample size we thus decided to only include and investigate the effects of these variables in model (2) of Table 3.1.

[34] We refer to a tailor as net receiver if he indicated to have received more money from his social network than he returned, and as net sender in the opposite case. This information was collected prior to the experiment during the initial survey on informal tailoring businesses in Ouagadougou described in chapter 3.2. Being a net sender increased the likelihood of producing zero bags (B.A3b).

better information to assess the income opportunity accurately, or that the family network can offer more effective assistance with the experimental task, which required adequate tailoring skills.

Interestingly, among the group of treated tailors, having a bank account is associated with a substantial decrease in the number of bags produced (column 7 of Table 3.1). A potential explanation for this is that bank accounts play an important role in the possibility to hide income from the kin network (Ashraf et al., 2015; Dupas & Robinson, 2013). Those tailors that regularly use bank accounts might be more strategic and thus react more strongly to the sharing obligation activated by the treatment. On the other hand, if a tailor's family network has not been informed about the income opportunity, participants with a bank account, who are also more strategic in evading sharing pressure, might be additionally motivated to increase bag production knowing that they might not need to share their earnings. It is noteworthy however to point out that model (6) of Table 3.1 shows a positive and significant treatment effect. This indicates that within the subsample of tailors who do not make regular use of a bank account (52.8% of our final sample), the treatment might have induced a weakly significant increase in average bag production, hinting at a potential link between our main (albeit insignificant) finding and the ability to hide income from the sharing network.

3.3.2. Adjustment Strategies and Self-reported Problems

The main reasons that explain the high number of zero bags include different personal or technical problems, as well as being too occupied with other tasks (see descriptive statistics in Table B.A3 and probit regressions in A3b).[35] Panels (c) to (f) in Figure 3.2 provide descriptive statistics on how these problems affected average bag production between both experimental groups. Given that we cannot differentiate between honest and dishonest excuses, our analysis focuses on different coping mechanisms – in general, and to these self-reported problems. Overall, 38.7% of tailors stated to have faced problems within the 24 hours of the experiment, especially problems related to electricity. Statistics on the types of recorded problems between both experimental groups are given in Appendix Table B.A3. 23.4% of the participants stated that they faced issues relating to electricity (e.g., outages), 12.1% stated they had problems with their sewing machine, and 5.7% stated to have had family-related

[35] In fact, we observe that reporting problems with the sewing machine significantly increases the probability to produce zero bags by 31% (p-value < 0.01; all margins calculated with the delta method based on probit regression coefficients in model (2) in Table B.A3b). This is plausible as the final product had to be made of rice bags which not every machine could handle easily. However, problems related to electricity reduce the likelihood to produce zero bags by 27.1% ($p < 0.1$). Apart from that, tailors born in Ouagadougou are 12.4% more likely to produce no bags (p-value < 0.01). While this potentially could be explained by differing network-related incentives between tailors with kin networks based in Ouagadougou or rural areas outside the city as suggested in Grimm et al. (2017), we do not find this finding to have a significant interaction with the treatment variable. We also observe a higher likelihood to produce no bags if a tailor stated to have received more financial help from the family and if they stated higher average profits from their tailoring business. This could theoretically be explained by a lower reliance on the additional money to be gained from the experiment. Business founders are significantly less likely to produce zero bags, but this result is driven by the small group of non-founders (there are only five non-founders in our final sample of 125 tailors).

problems. The fact that problems were reported equally often, both in the treatment and in the control group, gives us some confidence in the random nature of problems. This is backed up by the results from a probit regression (Appendix Table B.A3a) highlighting that none of our explanatory variables is correlated with a higher likelihood of reporting problems. As most self-reported problems rather slowed down production instead of leading to a complete inability to produce, it may require specific skills and extra effort of tailors to still produce bags.

The figures in Table 3.2 show that tailors in the two experimental groups adjusted their mode of working to their respective treatment conditions differently. While tailors in the treatment group asked more people for help both if problems occurred (1.73 vs. 1.19 total people working on the task; Mann-Whitney U-Test: p = 0.032) or not (1.72 vs. 1.37; Mann-Whitney U-Test: p = 0.023), tailors from the control group stated to have worked through the entire night significantly more often (22.39% vs. 10.53%; Mann-Whitney U-Test: p = 0.081), albeit this difference is not significant in case problems were encountered (11.54% vs. 4.55%; Mann-Whitney U-Test: p = 0.387). As indicated above, this is intuitive as one would expect tailors whose social networks have not been informed about the business opportunity to have a stronger incentive to hide additional income from their kin network, thus asking for less help but using all available effort by working all night to benefit as much as possible from the offer. Likewise, tailors from the treatment condition might as well ask more people to cash in on the opportunity as they do not have the option to hide it in the first place. This finding also mirrors the behavior exhibited by treated farmers reported in di Falco et al. (2018), who informed and asked significantly fewer people to help on their fields in order to hide windfall gains from the experimental intervention.

Table 3.2 – Adjustment Strategies: Asking Others for Help and Working all Night

	Control	Treatment	Difference (treatment - control)
	Avg. no of people helping		
# of people working on task (full sample n=124)	1.37	1.72	0.35**
# of people working on task (if problem occurred n=48)	1.19	1.73	0.54**
	No of cases		
worked all night (full sample n=124)	22.39%	10.53%	-11.86%*
worked all night (if problem occurred n=48)	11.54%	4.55%	-6.99%

**** p<0.01, ** p<0.05, * p<0.1 – p-values from simple t-tests. Findings confirmed by Mann-Whitney U-Tests.*

The analysis of mean differences between both experimental groups presented in Table 3.3 indicates that tailors from the two experimental groups performed significantly differently with regards to the bag production when they stated to have encountered problems during the production process: On average, tailors in the treatment group produced significantly more bags than control group tailors (6.36 vs. 4.08 bags; Mann-Whitney U-Test: p=0.055). Surprisingly, treatment group tailors were even able to increase their bag production when reporting problems, although this difference is not statistically significant. Overall, it appears that the effect of problems on bag production for control group tailors is much more pronounced: On average, tailors in this group managed to produce 2.58 fewer bags in case of reporting problems (Mann-Whitney U-Test: p=0.056). In Figure 3.2, panels (e) and (f), we observe that these differences can at least partially be explained by tailors from the treatment group exhibiting a lower share of zero bags produced when compared to the control group. However, the difference in zero bag production between both groups is not statistically significant (Mann-Whitney U-Test: p = 0.164).

The results presented in Table 3.3 also indicate that working all night translated to a significant increase in bag production for tailors in both groups (3.64 in the treatment group; Mann-Whitney U-Test: p=0.056 & 4.05 in the control group; Mann-Whitney U-Test: p=0.01). However, while this difference exhibits a higher degree of statistical significance in the control group, this is mainly driven by the relatively small number of observations for this specific adjustment strategy (see Table 3.2). Regarding economic significance, at less than half a bag difference, there is no indication that one experimental group really profited more from this adjustment strategy than the other. This does not hold for the second adjustment strategy highlighted in Table 3.3: Asking others for help in the production process, which we now investigate as a binary indicator variable for either asking people for help or not, to allow for a streamlined comparison of mean differences in bag production between both tailor groups. While we do in fact observe a similar trend to working all night, in that both groups of tailors managed to increase their bag production to a statistically significant degree (5.00 in the treatment group; Mann-Whitney U-Test: p=0.001 & 2.54 in the control group; Mann-Whitney U-Test: p=0.090), here the effect is much more pronounced for treatment group tailors, both with regards to statistical and economic significance.

Table 3.3 – Effect of self-reported Problems and Adjustments to Sharing Obligations on Bag Output

	Control	Treatment	Difference (treatment - control)
Problems Encountered			
if problem reported in production process (n=48)	4.08	6.36	2.29*
if no problem reported in production process (n=76)	6.66	5.63	-1.03
Difference	-2.58**	0.74	
Working all Night			
if reported to have worked all night (n=21)	8.80	9.17	0.37
if not reported to have worked all night (n=103)	4.75	5.53	0.78
Difference	4.05***	3.64*	
People Helping			
if reported to have received help (n=43)	7.44	8.72	1.28
if not reported to have received help (n=82)	4.90	3.72	1.18
Difference	2.54*	5.00***	

**** p<0.01, ** p<0.05, * p<0.1 – p-values generated from simple t-tests.*

4. Conclusion

We present results from a field experiment in Burkina Faso testing for the potential negative effect of sharing norms within kin networks on entrepreneurial effort. Contrary to previous evidence, suggesting income hiding as a response to sharing expectations in household and entrepreneurial settings, we find an insignificant treatment effect, which even goes in the opposite direction than expected (i.e., treated tailors produced more bags on average). Apart from the subtlety of our treatment intervention itself representing a potential explanation for the absence of a significant treatment effect, an explanation for the positive result could be that tailors in settings like this are typically self-employed and, due to self-control issues, often rely on target production (Dupas & Robinson, 2013). Assuming tailors in both experimental groups set themselves a specific target from the onset of the experimental activity, either reciprocity norms or redistributive pressure could have incentivized treated tailors to produce more bags. Another explanation for the absence of a treatment effect could be rooted in that the fact that our treatment was not binding enough. Treated tailors could have potentially still lied to their kin about the job opportunity. While we, unfortunately, have no ex-post evidence to investigate this possibility further, we do not assume this to be a widespread issue, as tailors would have needed to neglect the fact that they (seemingly) only received the job opportunity through their kin in the first place, actively lie in case of being asked, while also potentially fearing exposure should an informed family member make a surprise visit to the tailor shop at the same time.

In fact, our empirical analysis suggests that the insignificant finding could at least be partially rooted in the heterogeneous treatment responses of tailors in our field setting. Results document that tailors seem to adjust their production processes differently depending on the existence of reciprocal ties within the family and access to a bank account, leading to heterogeneous treatment effects. Similarly, tailors in the control group increase individual working hours whereas tailors in the treatment group tend to involve, and benefit from, their kin network that has been informed by the treatment manipulation. We therefore suppose that our subtle treatment intervention has led to varying adaptation reactions that each fit the context of the respective tailor. The ability to document these diverse responses highlights an important feature of our study, which is often difficult to achieve with lab-in-the-field studies typically imposing more control on participants' possible behavioral reactions.

The increase in nighttime working among tailors in the control group in combination with asking fewer people for help than tailors in the treatment group is consistent with patterns of evasive income-hiding behavior which are well-established in the literature (Ashraf, 2009; Beekman et al., 2015; Boltz et al., 2019; di Falco et al., 2018; Di Falco et al., 2019; Dupas & Robinson, 2013; Fiala, 2017; Jakiela & Ozier, 2016). Tailors whose families were left unaware of the lucrative income opportunity introduced by our experiment could have seen an easy opportunity to earn some money on the side without fearing the need to share the fruits of their labor. This tendency is additionally underlined by our finding that control group tailors produced significantly more bags if they regularly use a formal bank account to deposit their entrepreneurial earnings, which facilitates hiding income from the kin network even further. Other studies confirm that people in low-income countries are willing to use bank accounts as a means of keeping income secret from their family network even if bank account fees are high (Dupas & Robinson, 2013).

However, we are also able to present suggestive evidence that small-scale entrepreneurs might be able to utilize their network to their advantage if they lose the possibility to hide their income – a circumstance reflecting the normal business case. The potential positive impact of kin networks on entrepreneurial production is especially evident if problem-solving skills on relatively short notice are required: We observe that if tailors faced problems during bag production, those assigned to the treatment condition exhibit better problem-solving skills and can utilize additional workforce to their joint advantage. Tailors in the control group on average produce more than two bags less when encountering problems (more than a third of the group's average total output when no problems occurred). Relative to tailors from the control group, treated tailors are even able to slightly increase their average bag production in case they reported problems. Based on the mean bag production levels presented in Figure 3.2 and Table 3.3 (6.66 bags vs. 4.08 bags), we see that the average control group tailor in our experiment experiences a 38% loss in productivity when reporting a problem. In this light, our explorative findings could also be regarded as being in line with the notion of a more positive link between social capital and the adoption of improved (problem) management practices in risky environments (Wossen et al., 2015).

In sum, our findings are of particular relevance as they may help in initiating further research to improve our understanding of how kin networks and the norms working within them interact with entrepreneurial incentives. Especially as our results suggest that overall, the activation of social networks even leads to a (slight) overall increase in bag production and even more so when problems in the production process have to be overcome. While our results come with limitations due to a relatively small sample and reliance on ex-post explorative analysis, they do shed new light on the relationship between solidarity norms and business outcomes in low-income countries, warranting further empirical analyses by future research.

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Chapter 4 - On the Long-Term Sustainability Implications of a Large-Scale Solar Electrification Project in Rural Pakistan

by

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Abstract: Rural electrification initiatives involving the dissemination of solar home systems (SHS) are regarded as an important puzzle piece in the push toward the United Nations Sustainable Development Goal of universal electrification. Yet, the evidence on the socioeconomic impact of such projects is scarce with mixed results, while their environmental sustainability implications are mostly investigated with simulation studies. The study at hand provides evidence concerning the long-term implications of both of these dimensions. Our analysis is based on a survey of n = 1,206 households in rural Sindh, Pakistan of which half were provided with an SHS during a large-scale development initiative a decade earlier. We employ propensity score matching with overlap weighting to investigate the socioeconomic impact of the SHS provision, while the project's environmental performance is proxied by an analysis of SHS energy payback time. While we find conclusive evidence for an impact on socioeconomic indicators such as lighting and study hours, these effects depend heavily on whether households were able to maintain the SHS from the project implementation until the time of the household survey. As only one-third of households in our study sample were able to do so, this also hampers the electrification project's overall sustainability performance.

JEL Classification: O12, O22, O33, Q20, Q56

Keywords: Rural electrification, Solar home system, Impact evaluation, Quasi-Experiment, Environmental performance, Pakistan

4.1. Introduction

For more than a decade, the role of electricity as a means to reduce poverty, especially in rural areas of low-income countries, has been evaluated and discussed in academic literature (Cook, 2011; Komatsu et al., 2011; Wamukonya, 2007). Numerous empirical studies provide evidence for causal linkages between electricity access and socioeconomic development (Bhattacharyya, 2006; Kanagawa & Nakata, 2008), a relationship that was brought into a much broader spotlight when the United Nations (UN) included "Affordable and Clean Energy" as one of the Sustainable Development Goals (SDGs) (UNGA, 2015), which was further institutionalized with the UN's Sustainable Energy for All (SE4All) initiative, aiming for universal electrification by the year 2030. However, the reality continues to look dreary: Recent World Bank figures suggest that in 2020, still 940 million people (13% of the world's total population) lacked access to electricity entirely (Ritchie et al., 2020) [36] While the overall share of households without electricity access has been steadily decreasing over the last twenty years, data suggests there is still plenty of work to be done, especially in rural areas throughout Africa and South Asia, which represent the majority of people without electricity access (Ritchie et al., 2020). In these areas, the expansion of national grid lines is hampered by a multitude of factors, however predominantly by the subpar investment prospects due to the oftentimes remote location of unelectrified villages, as well as the low-income levels among rural households (Ahlborg & Hammar, 2014; Dugoua et al., 2017).

Against this background, it becomes increasingly apparent that the extension of national electricity grids cannot be the singular solution to achieving the goal of universal electrification. Thus, development policy-makers eye alternative, decentralized technologies. While these are typically situated on lower tiers of the SE4All multi-tier framework for defining and measuring access to energy (Bhatia & Angelou, 2015), they can still help in bridging access barriers, while providing rural households with adequate energy levels to power basic electrical appliances. This is why solar technology is often regarded as an important cornerstone in the pursuit of universal electrification (Adenle, 2020). In rural solar electrification projects, households are typically provided with Solar Home Systems (SHS) of varying types. These usually consist of the solar panel itself, a battery to store electric energy generated during the daytime, as well as a charge controller and cabling to power electric home appliances such as lamps, fans, or mobile phones (Wamukonya, 2007). In light of the SDGs added focus on issues of sustainability, the concept of rural electrification through solar energy has a twofold appeal: Firstly, especially when compared to electricity grid extension to remote areas, solar electrification causes relatively low costs in both production and dissemination of the required infrastructure. Secondly, once installed solar systems do not cause any greenhouse gas (GHG) emissions in electricity production (Adenle, 2020; Szabó et al., 2011). Adding to this appeal, many of the world's regions with the lowest

[36] These figures are based on the definition of electricity access as the possession of an electricity source that can provide basic lighting, as well as mobile charging for at least 4 hours per day (Ritchie et al., 2020).

electrification rates today feature high average solar irradiance figures, creating significant potential for solar electrification interventions (Kabir et al., 2018).

However, despite solar technology's positive outlook to play a decisive role in bridging rural electrification gaps across the globe, recent literature indicates that there are some important caveats to this promise: For example, the actual payoff of the aforementioned dual appeal of solar technology crucially depends on an effective implementation into local markets, which carefully need to take existing socioeconomic and cultural structures into account (Cook, 2011). Additionally, an effective solar dissemination project that aims to fulfill promises of long-term development through self-sustaining local markets should optimally be built on a functioning infrastructure of local entrepreneurs with adequate technological expertise (Wakkee et al., 2014). This is especially important as off-grid solar electrification projects are frequently subject to severe issues relating to the quality of the provided SHS resulting in early product outages at high rates (Groenewoudt et al., 2020). Strict quality assurance of components, as well as the provision of adequate maintenance services is therefore regarded as crucial to safeguarding positive project outcomes from a sustainable development perspective (Chowdhury & Mourshed, 2016).

Partially reflecting such issues, rigorous impact studies (i.e., employing randomized controlled trials (RCT) or quasi-experimental evaluation methodology) evaluating the socioeconomic effects of SHS dissemination projects on rural households have brought forward spotty and sometimes even inconsistent evidence. Even though reported effects on electricity take-up and SHS use are generally positive (Aklin et al., 2017; Bensch et al., 2013; Grimm et al., 2017; Samad et al., 2013; Wagner et al., 2021), and most studies being able to identify significant effects relating to educational outcomes as measured by an increase in children's study times at home (Bensch et al., 2013; Grimm et al., 2017; Hassan & Lucchino, 2016; Samad et al., 2013), reported effects on financial indicators of socioeconomic development are mostly small (Aklin et al., 2017; Grimm et al., 2017; Samad et al., 2013; Wagner et al., 2021) if detected at all. This evidence already puts one side of the sustainable development narrative promoting solar electrification into question.

Another strand of literature is concerned with evaluating the environmental implications of solar electrification programs in rural areas. While it is clearly pointed out that the sustainability performance of SHS electrification projects depends on the correct use of the technology, requiring awareness and educational interventions among rural consumers (Azimoh et al., 2014), the main technological factor determining the overall ecological footprint of such interventions is the types of batteries that are typically used to store the energy generated from the panels, as well as battery replacement rates (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021; Ayeng'o et al., 2018; Diouf & Avis, 2019; Narayan et al., 2018). Due to relatively low production costs and high market penetration rates, SHS markets in the Global South are still dominated by lead-acid batteries (LAB), which typically have a significantly increased ecological impact when compared to, e.g., lithium-based or nickel cobalt aluminum batteries, mainly due to LAB's subpar and relatively quickly degrading storage capacities, as well as higher degrees of acidification (Ayeng'o et al., 2018; Yudhistira et al., 2022). As with the other SHS components, LAB lifetime depends on the proper use of the entire system, where battery lifetime is specifically affected by deep battery discharges related to frequent over-utilization of the SHS (Azimoh et al., 2014). These issues contribute to the fact that case studies conducted in Sub-Saharan Africa report LAB lifetimes between 1-3 years (Fuentes et al., 2018; Gustavsson & Mtonga, 2005), which is less than half of the LAB lifetime assumed in theoretical optimization studies (Narayan et al., 2018). While environmental life-cycle assessment (LCA) studies conducted in Bangladesh indicate that SHS electrification projects can indeed avoid substantial amounts of CO_2 emissions (Hossain et al., 2019; Sarker et al., 2020), these studies assume that based on optimal use of the SHS, maximal panel lifetimes of between 20 and 25 years are actually reached. Keeping in mind the manifold issues related to SHS use listed above, this assumption is likely unrealistic.

The study at hand provides evidence concerning the long-term socioecological implications of a large-scale SHS-based rural electrification project that was implemented in rural Sindh, Pakistan between 2009 and 2013. Our focus rests on both aspects of the sustainable development duality: While the first part of the analysis presented in this paper investigates the project's development implications by conducting a quasi-experimental socioeconomic impact evaluation (propensity score matching), the project will also be examined regarding its environmental performance using LCA methodology with a focus on efficiency as measured by energy payback time (EPT). The basis for both parts of the analysis is a household survey conducted from December 2020 to January 2021 (n = 1,206). To enable our quasi-experimental impact evaluation, half of the sampled households were provided with an SHS during the electrification project, while the other group benefitted from an alternative intervention. The study setup allows for a thorough investigation of the project's sustainable development implications in a global region that represents an ideal case study for SHS electrification interventions. This is due to South Asia's high share of unelectrified households, the high solar potential due to its geographic location, as well as the fact that decentralized renewable energy solutions like SHS are increasingly being distributed in this area (Ojong, 2021; Palit, 2013). We make contributions to two specific strands of literature: Firstly, the rigorous socioeconomic impact evaluation presented in this paper adds to the relatively scarce evidence brought forward in related publications involving SHS or comparable systems (Aklin et al., 2017; Bensch et al., 2013; Furukawa, 2014; Grimm et al., 2017; Hassan & Lucchino, 2016; Samad et al., 2013; Wagner et al., 2021). While the observation period in the cited studies ranges only between 1 and 4 years, we try to identify development effects after about one decade.[37] We additionally contribute

[37] Naturally, a shorter observation period is frequently justified for cost-related reasons, to minimize issues related to attrition or the introduction of confounders, especially as four of the cited studies implemented a randomized controlled trial (Aklin et al., 2017; Furukawa, 2014; Grimm et al., 2017; Hassan & Lucchino, 2016).

to filling literature gaps on the environmental performance of SHS dissemination projects in the Global South (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021; Kizilcec & Parikh, 2020), thereby also providing insight into the interplay between both sustainability and development aspects of such projects.

The implications of both parts of the analysis are heavily affected by whether households were able to maintain their SHS from dissemination up to the time of our household survey, thereby underlining the importance of taking follow-up service and supervision in the context of rural electrification projects seriously. In fact, only one-third of households were able to keep the SHS running over a timeframe of approx. ten years, mostly stating technical malfunctions as the main reason for this circumstance. A significant impact of receiving an SHS on appliance ownership, lighting, and study hours, as well as health outcomes, is magnified or can only be observed if only households are investigated which reported to still be using the provided SHS. This differentiation also dictates our conclusions regarding the project's environmental efficiency: A majority of households that stated not to be using the SHS anymore were able to maintain the system for five years or more – a timeframe that is at least relatively close to efficiency thresholds as set by the EPT calculations performed in this study. However, these thresholds already reflect best-case scenarios which, as suggested by our observations from the household survey, are only realistic in a small number of cases.

4.2. Methodology

4.2.1. Study Context and Sampling

Our analysis is based on a quasi-experimental impact evaluation of the *Sindh Coastal Community Development Project* (SCCDP). The SCCDP was funded with a total of USD 36 million by the *Asian Development Bank*, while partnering NGOs carried out development interventions in the timeframe between 2008 and 2014. These included both household and village-level interventions addressing sanitary needs (e.g., household water supply & toilets), education (e.g., renovation and construction of schooling facilities), transport (e.g., construction and maintenance of roads and bridges), as well as microfinance and energy access projects (Asian Development Bank, 2014). The focal point of the energy access interventions was the dissemination of 4,515 SHS to 186 villages in the districts of Badin, Thatta, and Sujawal.[38] Based on first-hand information from our partner NGO, the *National Rural Support Programme* (NRSP), which was involved in the implementation of the SCCDP and provided assistance to our field research project, these SHS generally consisted of one 30W polycrystalline panel, a charge

[38] Note that during the majority of SCCDP implementation, the Sujawal district was still part of the Thatta district, which was split to form the new Sujawal district in October 2013.

controller (12V, 1 AMP), a battery (12V, 17AMP), three 5V light bulbs and a charger for mobile phones. These SHS were disseminated to beneficiary households between August 2009 and April 2013.[39]

Against this background, two distinct data sources form the basis for our analytical approach regarding both socioeconomic impacts, as well as the environmental performance of rural electrification projects involving SHS. Firstly, we employ baseline data on village-level characteristics including basic geographical information about villages' distance to the coastline or the next paved road, as well as further socio-economic background characteristics like the prevalence of schools, markets, sanitation, health facilities, and electricity. This data was collected by NRSP prior to the implementation of any SCCDP-related development interventions, i.e., before the first interventions in 2008. Villages were assigned scores with regards to how they were classified on the above-mentioned criteria before the aggregate score was used to determine a village's suitability for being selected for a development intervention as part of the SCCDP. While NRSP, unfortunately, could not provide us with exact information as to if or how this score resulted in the selection of villages into specific intervention types, e.g., based on certain cutoff scores, we regard this data as a valuable resource for our quasi-experimental approach of propensity score matching, which is discussed in more detail in the following sub-sections. Also, NRSP could only provide us with baseline data on villages that were selected to be provided within the SCCDP, which is we are not able to employ a "proper" control group for our quasi-experiment. As a second-best option, we chose to select villages that were provided with sanitation interventions (toilet access) as our experimental comparison group. This decision was based on two criteria: Firstly, compared to other intervention types, the total amount of villages (222) provided with sanitation interventions, as well as their geographical distribution across the study region was relatively comparable to that of the SHS villages. Secondly, we expected the majority of our socioeconomic outcome variables to be only weakly (if at all) affected by any kind of sanitation treatment.[40] From here on, we will refer to SHS-provided villages as 'solar' villages and to the villages provided with the sanitation intervention as 'control' villages (as well as solar/control households respectively).

Next to village-level data collected before the SCCDP implementation, we employ data that was collected during a household survey between December 2020 and January 2021. This household survey

[39] Our field research revealed slight variations with regards to the exact SHS specifications across project beneficiary households, probably due to changes in solar panel supply across the dissemination period of more than three years.

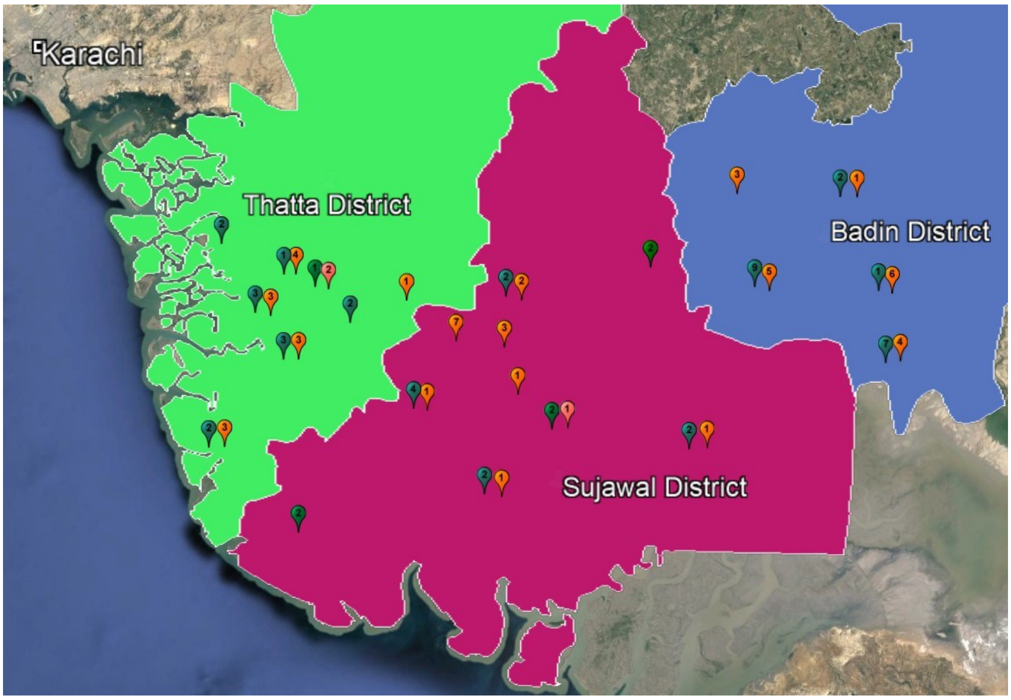
[40] While there are a number of studies concerned with potential sanitation effects on educational outcomes, providing positive evidence for a sanitation impact on cognitive development, results with regards to school absenteeism are mixed at best (Sclar et al., 2017). Our educational outcome variables revolve around study behavior in the household. Apart from this, sanitation impacts are mostly assumed to be related to health outcomes (Bartram et al., 2005), with the literature providing generally positive evidence (Jasper et al., 2012), albeit the longevity of these effects is put into question (Hammer & Spears, 2016). While we naturally cannot rule out potential positive health impacts from the SCCDP sanitation interventions affecting any of our socioeconomic outcomes indirectly, we try to account for this by using information on household health as control variables in our regression models.

represents our main source of data. In preparation for this survey, our team trained a total of 17 enumerators on-site over the course of five days. After two days of pilot interviews, a number of feedback sessions, and an inspection of the collected data, which was followed by an additional two days of final training, the main survey-work commenced. Villages to be visited were randomly drawn from full lists of both solar and control villages, as specified above. As enumerators were split into three teams, each assigned to one of the three districts within the study region to avoid overly long travel times, the total number of villages drawn was split equally across districts. We also kept the ratio of solar and control villages equal across districts. We randomly sampled a total of 60 solar and 60 control villages. Enumerator teams were contracted to visit 1-2 villages per day (based on the number of available households in the village visited first and logistical convenience) and to alternate between solar and control villages to ensure balance group sizes for a total of 30 days. All enumerators were paid in daily rates (not per completed survey) in order to prevent incentivization to rush through surveys and were only asked to complete 3-4 surveys per day to minimize mistakes based on fatigue. Resulting of these instructions, the number of households interviewed per village ranges between 5 and 17, with the average amount of households per village sitting at 12.1. Within the villages themselves, enumerators were instructed to sample households according to a random walk procedure. While visiting solar villages, households were specifically asked to only interview randomly sampled households if the unambiguously stated to have received an SHS during the SCCDP timeframe. In total, 98 out of the 120 randomly sampled villages (equally split across both village types) were visited. This procedure resulted in a sample of 1,206 surveyed households (601 solar and 605 control households) of which a total of seven from the solar group were dropped due to a wrongful household classification by the enumerators.[41] To provide insight into the geographical distribution of our observations, all villages visited by the enumeration teams are plotted on the map depicted in Figure 4.1. The average total time to complete the survey was 51 minutes.[42]

[41] These households were situated in SCCDP provided villages and were sampled based on the fact that they had received a SHS during the project. However, going through specific control questions revealed that they were not provided after all, leading us to drop those observations altogether.

[42] Note here that the survey completion time varied substantially with the household electrification history, household size etc. as certain responses triggered additional sets of questions etc.

Figure 4.1 – Map Illustrating the Sampled Villages by Union Council



Note: The map highlights the three sampling districts located in Sindh's coastal region, southeast of Karachi. The number of solar villages sampled within a union council (local government tier) is given in the green pins. The red pins contain the corresponding number for the control villages.

4.2.2. Descriptive Sample Statistics

Table 4.1 lists descriptive statistics on various socioeconomic and geographical indicator variables between solar and control households. The first four variables listed in this table originate from the baseline village-level survey described in the previous subchapter, while the remainder of the variables was collected within the scope of the household survey in 2020/2021. While we do observe several significant differences between household types, most of them relate more or less directly to the geographical situation of the villages. The first two variables clearly indicate that solar households were located more closely to the coast, which in the case of our study region goes hand in hand with a longer distance from the nearest asphalt road. It therefore becomes apparent that the remoteness of a village's location, and in turn its distance from the nearest electricity grid lines, which in Sindh are mostly located alongside the main roads, was a crucial factor in selecting villages into the SCCDP SHS intervention group. These differences can also provide an intuitive explanation for the on average worse educational indicator outcomes among solar households as their more remote location hampers access to schools already from a logistical perspective. The higher propensity among solar households to construct their homes from low-quality products is also likely related to the fact that households in coastal Sindh need to reconstruct their homes more frequently due to exposure to storms, floods, etc. As further explained in the following subsection, the variables listed in Table 4.1 form the basis of our propensity score weighting approach, meaning that the socioeconomic differences are accounted for in our econometric analysis.

Table 4.1 – Descriptive Statistics on Household Characteristics Between Village Types

SCCDP	0		1				
	N	Mean/SE	N	Mean/SE	t-test Difference (1-0)	Min	Max
Household characteristics							
Village distance to coast in km	605	25.030 [0.736]	594	10.456 [0.431]	-14.574***	0	60
Village distance to nearby road in km	605	2.625 [0.214]	594	4.591 [0.195]	1.966***	0	33
Village size (Total number of households)	605	32.630 [0.716]	594	31.919 [0.658]	-0.711	18	105
Village has no link to other administrative department	605	0.764 [0.017]	594	0.788 [0.017]	0.024	0	1
Age household head (years)	605	44.357 [0.487]	594	45.333 [0.447]	0.976	15	84
Household head years of education	605	2.603 [0.168]	594	1.717 [0.140]	-0.886***	0	15
Household head is married	605	0.945 [0.009]	594	0.943 [0.010]	-0.003	0	1
Household head is female	605	0.126 [0.013]	594	0.089 [0.012]	-0.036**	0	1
Number of children >8 years old	605	1.674 [0.062]	594	1.736 [0.059]	0.061	0	7
Share of male children >8 years old (in percent)	605	0.373 [0.016]	594	0.414 [0.016]	0.041*	0	1
Child with >7 schooling years	605	0.089 [0.012]	594	0.045 [0.009]	-0.044***	0	1
Years of residence	605	45.334 [0.954]	594	43.332 [0.814]	-2.002	1	100
Roof is made of wood/straw/mud	605	0.779 [0.017]	594	0.872 [0.014]	0.094***	0	1
Floor is made of earth/wood/stones	605	0.251 [0.018]	594	0.170 [0.015]	-0.081***	0	1
Wall is made of earth/wood/straw	605	0.848 [0.015]	594	0.944 [0.009]	0.097***	0	1
Number of household members	605	8.311 [0.157]	594	8.993 [0.176]	0.683***	1	20

4.2.3. Evaluation of Socioeconomic Impact

Our investigation of the socioeconomic impact related to the SHS dissemination within the SCCDP is based on a detailed literature review on the socioeconomic impact of rural electrification (see Appendix section C.A) and the corresponding theory of change framework depicted in Appendix Figure C.A1. Following this theory of change, we identified the following variables as key indicators for socioeconomic development: First off, we summed the total number of electric appliances present in the households, as well as the number of lighting hours per day as indicators to evaluate the effect of the SHS provision on the extent of electricity use.[43] Secondly, to investigate the health-related impacts of solar electrification we use a binary indicator to capture the prevalence of respiratory problems in the household. If the household reported at least one member with breathing problems the variable is set to one. We additionally employ a variable generated from a Likert-scale-based self-assessment of the households' overall health status. Economic activity and financial household welfare are proxied by the total monthly expenditures per capita which were generated by summing up a multitude of expenditure categories (e.g., monthly spending for food, mobile phone top-up, or medical bills, as well as yearly spending for hospital bills and education). To address educational outcomes, we quantified children's study habits by the total number of daily study hours and the total number of study hours during the night.[44] The more intangible (i.e., attitudinal) impacts of the SHS dissemination are evaluated using indicators for self-perceived life satisfaction and feeling of security during night times, both measured based on a five-point Likert-scale. Those variables (descriptive statistics listed in Table 4.2), allow us to gain insight into the effects of solar electricity on each welfare dimension listed in Figure C.A1.

[43] Specifically, we added up the hours per day light bulbs, battery lamps and solar torches were used by the household.

[44] After investigating the data, we decided to pool and sum the time children spend with homework per household and do not calculate the study times per child. Since only 30 percent of households in our sample indicate that they send their children to school, resulting in a quite substantial amount of zero observations in the number of children enrolled per household and in the outcome variables concerning children's study habits.

Table 4.2 – Descriptive Statistics on Outcome Variables Between Village Types

SCCDP	0		1				
	N	Mean/SE	N	Mean/SE	t-test Difference (1-0)	Min	Max
Outcome variables							
Total electric appliances	605	2.193 [0.088]	594	1.389 [0.059]	-0.804***	0	17
Total daily light hours	605	3.395 [0.105]	594	3.288 [0.112]	-0.107	0	24
HH member with breathing problems	605	0.182 [0.016]	594	0.158 [0.015]	-0.024	0	1
Health status	605	1.136 [0.041]	594	1.081 [0.044]	-0.055	-2	2
Total daily study hours	605	3.084 [0.223]	594	1.951 [0.191]	-1.133***	0	30
Total study hours after nightfall	605	0.524 [0.052]	594	0.333 [0.046]	-0.191***	0	10
Total monthly expenditures p.c. (log)	605	0.910 [0.027]	594	0.878 [0.029]	-0.033	-2.56	3.808
Life satisfaction	605	1.284 [0.040]	594	1.264 [0.040]	-0.020	-2	2
Feeling of security at night	605	0.015 [0.069]	594	-0.077 [0.069]	-0.092	-2	2

Our empirical strategy is characterized by two approaches adopted from RCT principles guiding the analysis of treatment effects: Firstly, the outcomes are compared between households provided with an SHS during the SCCDP (solar households) and control households. Throughout the paper, we are going to refer to this approach as intention-to-treat (ITT) analysis. By employing this approach, we aim to capture the average socioeconomic effect of assigning households to the SHS provision. The average outcomes generated from this part of the analysis therefore reflect a real-world situation in which the implementing agencies behind development interventions decide to disseminate solar electricity to rural households in largely unelectrified regions (Tripepi et al., 2020). Secondly, we exploit the variation regarding the SHS functionality status at the time of the household survey, which allows us to separately analyze the subgroup of solar households that still used the SHS at this point in time. We refer to this part of the analysis as the as-treated (AT) approach. Following this approach, we aim to estimate the average effects of using the SHS for a substantial amount of time (eight to twelve years between the initial dissemination and the household survey), i.e., this approach also allows us to approximate the true long-term effects of being provided with solar electricity (Smith et al., 2021; Tripepi et al., 2020). Intuitively, we expect treatment effect estimates obtained by the AT approach to be generally larger when compared to the ITT analysis, as causal effects linked to electrification are manifested via the use of electric appliances, which naturally can no longer be powered if households lose their access to a constant electricity supply (Smith et al., 2021). Generally, households that gained a connection to the national electricity grid sometime between the initial SCCDP dissemination phase and the household survey were excluded from the analysis independently of the treatment arm. This was done to avoid confounding due to additional or alternative electricity sources and to adhere to the principle of finding a counterfactual outcome for the treated, who did not have been electrified in the first place.[45]

To ensure a high degree of comparability between solar and control households in our main socioeconomic impact analysis, we employ a propensity score weighting approach (Austin, 2011; Li et al., 2017; Rosenbaum & Rubin, 1983). Such quasi-experimental approaches are typically employed when causal effects, due to a non-randomized distribution of treatments within an intervention, cannot by estimated by a simple comparison between treatment and control observations. The specific characteristics of the case study at hand, with no availability of detailed household data from the baseline and the unclear criteria behind the distribution of different development interventions within the SCCDP, unfortunately, rule out alternative quasi-experimental approaches such as difference in differences or regression discontinuity designs. To account for the specific characteristics of our study setup, as well as the nature of our data with a relatively small overlap in propensity scores between both experimental groups, we employ the relatively novel overlap weighting approach (OW) (Li et al., 2017; Li & Thomas, 2019; Thomas et al., 2020) to weight observations based on their propensity score and thereby balancing socio-economic background characteristics. A detailed discussion of our approach is provided in Appendix Section C.B.

The average treatment effects in the propensity score overlap between both experimental groups are then investigated by regressing the outcomes on a binary indicator representing SHS provision during the SCCDP. In addition, as indicated in the previous subsection, variables used in the propensity score estimations are included as explanatory variables in the subsequent weighted regressions to avoid an omitted variable bias (Ho et al., 2007).[46] We applied weighted ordinary least squares (OLS) regression analysis to outcomes of interest measured on a continuous scale. For binary scaled outcomes, we employ probit regression models and calculate predicted proportions afterward to estimate the marginal difference between the treatment groups. The potential effects of the SHS on ordinal outcomes are obtained by the application of a tobit regression. To investigate the effect of SHS provision on the number of study hours, we employ additional modeling to account for low school enrollment rates in

[45] We relaxed the sample exclusion criteria concerning minor electricity sources. It was decided to do so as torches where mostly mentioned as replacement or additional electricity sources. We did not want to scale down our sample further after excluding around one third (32.44%) of observations for their grid electricity status. Also, battery-powered lamps or solar-torches as those are exclusively used for lighting purposes and cannot power larger appliances, thereby reducing their confounding potential for welfare effects. In addition, usage data on the mentioned lamps indicates that a fraction of households apply those devices since eight up to fifteen years. Way before the SCCDP SHS provision started.

[46] Each observation included in the regression analysis is weighted by their respective overlap weight.

Pakistan and Sindh (Asim, 2013), which are also present in our sample.[47] This circumstance led to an excess of zero observations in the respective variable measuring study habits, as children might be school-aged but do not study at home because they have never been sent to school in the first place. We address this circumstance with the application of zero-inflated negative binomial (ZINB) regression models (Yau et al., 2003). While the intuition behind the ZINB model is that excess zero observations can be explained by an additional model,[48] its nested structure enables us to separate zero observations which can be explained by not being enrolled in school at all from zeros indicating children that are enrolled but do not study at home.[49] To obtain a marginal treatment effect, we calculate the difference between treated and control households by predicting the average mean counts in each treatment arm from the ZINB regression model. We also run the regression models in the unweighted and propensity score-weighted samples to control for a potential bias arising from focusing on the part of the sample within the area of overlap (Rosenbaum & Rubin, 1985). Additionally, we employ standard errors clustered at the village level, which is reasonable as the SHS were disseminated to benefit multiple households in one village, and sampling followed a two-stage process (Abadie et al., 2017; Austin & Small, 2014). Additionally, to address the potential for reporting false positive results resulting from multiple hypothesis testing, we control the false discovery rate by calculating adjusted p-values (also called q-values) first introduced in Anderson (2012).[50]

4.2.4. Evaluating the Efficiency of SHS

For our investigation of the environmental performance of the SHS dissemination within the context of the SCCDP, we follow the general approach brought forward in Antonanzas et al., (2019) and Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al. (2021). The basis for all calculations is the technical SHS specifications outlined in subchapter 4.2.1., additional information from the SCCDP implementation phase, both provided by NRSP, as well as household-level information on electricity usage patterns collected during the household survey. Our main metric of interest is energy payback time (EPT) of the full SHS, i.e., the SCCDP-provided solar panel and all ancillary components, i.e., LABs, charge controller, as well as cabling and wiring. While EPT only represents one aspect of the overall environmental performance of a product or system, the metric does provide a straightforward indicator for product efficiency, where a shorter EPT clearly indicates a higher degree of environmental

[47] Within our sample, 66.40% of households reported zero years of schooling years for their oldest child (if seven years or older).
[48] In our case, the number of zeros can be predicted by the number of enrolled children per household.
[49] The ZINB model adjusts the variance of the dependent variable for overly dispersed data, which distinguishes it from a zero-inflated Poisson (ZIP) model. Although both kinds of models perform equally when no overdispersion is present, we provide Akaike and Bayesian information criteria as a fit statistic in Appendix Tables C.C4 & C.C5 (Amalia et al., 2021).
[50] The null hypothesis in these tests is having a false positive finding.

friendliness without necessarily needing a comparison on a wider spectrum of individual ecological indicators. Following the approach postulated in the above-cited literature, we define EPT as:

$$EPT = \frac{CED}{E_{user} * CF} \tag{1}$$

where CED is defined as the cumulative energy demand of the full SHS life cycle, E_{user} as the annual electricity use of the SHS user, and CF as a factor describing the conversion from primary energy to ready-to-use electricity.[51]

We obtain CED figures based on the LCA performed in Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al. (2021), which was conducted in *openLCA 1.10.2* using life cycle inventory (LCI) data on the two life cycle steps of manufacturing, transportation, and recycling. The employed LCI data originates from *ecoinvent 3.4*, with the exact product specifications themselves being based on a review of related literature (Xie et al., 2018). Manufacturing LCI of the solar panel follows the literature review performed by Xie et al. (2018) with slight updates, while GREET model information is used for the LAB manufacturing LCI. The wiring (copper wire of 2.5 mm^2) and the charge controller (0.015 kg of electronic components and 0.060 kg of polyvinyl chloride) were modeled based on *ecoinvent 3.4* background information (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021). The exact life-cycle inventories employed in the above-cited study are given in Appendix Table C.C1. CED for SHS component transportation was inferred from the same publication on the basis of two manufacturing countries with different shipping route distances to Karachi, Pakistan (8,000 and 9,000 km for Germany and China respectively), which were approximated using measurement tools in Google Earth. As in the main reference paper (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021), recycling is considered in the full CED calculations for the full set of SHS components, however, due to a lack of available LCI data on informal solar panel and LAB recycling in Pakistan, only as formal recycling to European standards.[52] As informal LAB recycling associated with high degrees of ground lead contamination is common practice in South Asia (Joshi et al., 2021) and other regions in the Global South (Bensch et al., 2017; Gottesfeld et al., 2018), which was also frequently reported for our study site in the context of expert interviews, all CED results which form the basis for EPT calculations should therefore be regarded as lower-bound estimates.

[51] As CED reflects primary energy demand and the output generated from the SHS is expressed as electric energy, a conversion factor between the two is needed. Following the recommendations brought forward in Antonanzas-Torres, Antonanzas, & Blanco-Fernandez (2021) & Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al. (2021), we employ the conservative conversion factor of CF = 2 throughout all our calculations.
[52] I.e., SHS CED only differs between study sites regarding manufacturing and transportation figures.

While NRSP indicated all solar modules disseminated during SCCDP to be of German origin, many observations on-site revealed that only a relatively small number of SHS were actually labeled to be of German origin, and in many cases, the information given on the product contained hints that the labels were potentially fake.[53] We still take the possibility of German products into account, which is why we employ the above-mentioned differentiation between Chinese and German origin of solar panels and LABs.[54] Photos taken from the LABs employed with the SHS also revealed a high degree of heterogeneity regarding battery manufacturers and sizes, which is why our analysis differentiates between two distinct LAB sizes which were frequently encountered in solar households (translating into weights of 2.5 kg and 7 kg). We lastly differentiate between LAB replacement frequency. Solar households that still operate the SCCDP SHS reported an average battery replacement frequency since first owning the SHS of 5.15 times, which, based on the time since project implementation, would roughly translate to a LAB replacement rate of every two years. This frequency is also reflected in the scenario building reported in (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021). We therefore take a high replacement rate of every two years, as well as a low replacement rate of every four years into account. The combination of these differentiations (SHS origin, LAB size, and LAB replacement rate) culminates in a total of sixteen scenarios considered for the calculations of the total SHS CED, as well as the resulting EPT estimations. The final assumptions for our CED calculations are that all panels have a power rating of 30W panels (as listed by NRSP documents and widely confirmed by our household surveys), a panel lifetime of 20 years for both the solar panel and the cabling/wiring, as well as a lifetime of 5 years for the charge controller.

Estimations for the E_{user} figures were obtained by performing a simulation of the SHS operation (including usage patterns) in the *PVsyst 7.3* software. The SHS was modeled as closely as possible to the technical specifications reported in subsection 4.2.1. with the average annual energy yield of the system being determined by irradiation values obtained from PV-GIS data from Sujawal. It should be noted that these simulations are based on new and optimally functioning solar panels and batteries. This circumstance of course is not representative of what was observed in the field during household interviews, with solar panels often being covered in dust, while batteries are, as already indicated in the introduction, oftentimes wrongfully operated by rural households. It can therefore be assumed that all E_{user} calculations serving as the basis for our EPT outcomes are overestimations. SHS usage was modeled according to our average survey results in solar households that still operate the SCCDP system: We assumed two mobile phones and two lamps to be used with the SHS (5W each) with the

[53] Enumerators were able to take photos of the solar panels in 150 of the 199 solar households that stated to still use the panel provided during the SCCDP. In the remaining instances, solar panels were installed on the roof and not accessible for our enumerators in a safe manner. Among the 96 households in which a panel manufacturer could clearly be identified (in other cases labels were removed, damaged or not readable on the photos) our data indicates a high degree of variation between companies, with many clearly indicating Chinese origin.

[54] The remaining SHS components' CDE only differentiates regarding transport but not the impact of the manufacturing country themselves.

lamps assumed to be used for four hours per day and mobile phones charged for two hours per day. The full simulation report is provided in Appendix Section C.D.

To make final statements on the efficiency of the SCCDP solar electrification intervention, the final EPT estimates from all scenarios are then compared against figures from our solar household survey, indicating in how many cases the required SHS runtimes, i.e., a net zero energy demand could even be achieved in the first place.

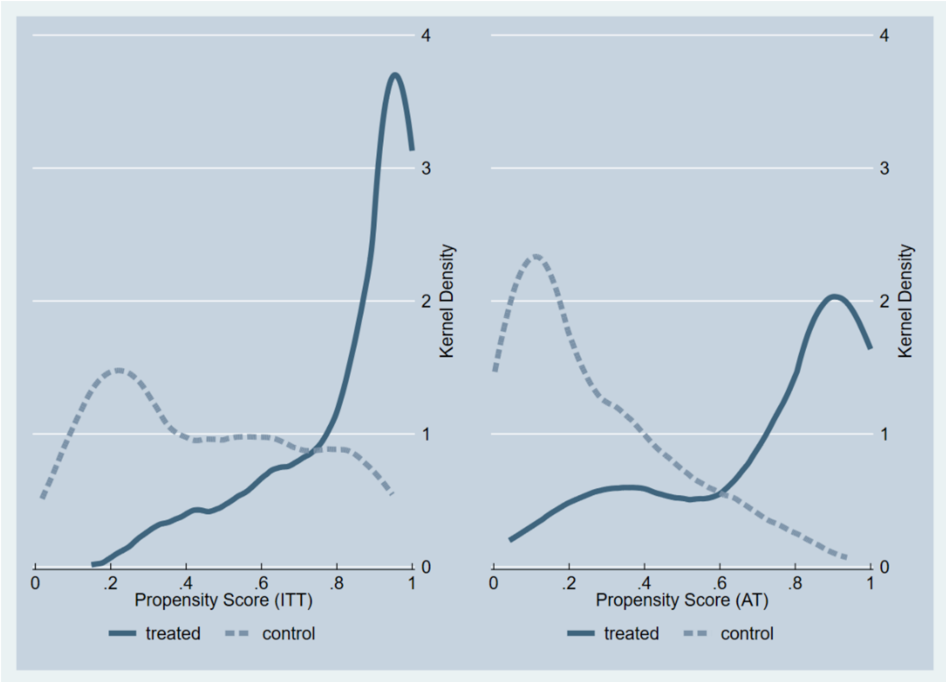
4.3. Results

4.3.1. Socioeconomic Impact

Based on propensity score estimations following the procedures described in Appendix Section C.B, Figure 4.2 displays the distribution of propensity scores in the two experimental groups for both the ITT and the AT approach.[55] The graphical illustration underpins our reasoning for opting in favor of the OW approach, with the highest densities of observations being located around the extremes of the propensity scores, leading to overlaps that are not exhaustive in both observed cases. The tables on balance between both experimental groups provided in Appendix C.C4 and C.C5 display the raw standardized mean differences for each covariate, as well as the differences after applying OW. While the raw samples exhibit imbalance for several variables, for instance, a village's distance to the coast highly exceeds the proposed cut-off point of 0.25, after weighing an exact balance in means of all variables included in the propensity score models is achieved.

[55] Detailed outputs of the propensity score estimations can be found in Appendix Table C.C3.

Figure 4.2 - Distribution of Propensity Scores



The impacts of the assignment to the SCCDP's scholar electrification intervention (ITT) and the effects concerning the long-term usage of an SHS (AT) as motivated in the previous chapter are depicted in Table 4.3. As expected, all ITT point estimates are smaller in magnitude for all investigated outcomes. We first address our two indicator variables for electricity use/uptake: Apparently, the total number of electric appliances owned increases significantly in response to the solar treatment (between 0.599 and 0.982), depending on whether the ITT or AT effect is investigated.[56] However, the long-term usage of an SHS is linked to a reduction in daily lighting hours by 1.3 hours (78 minutes) when looking at the AT effect, while there is no significant effect in the ITT specification. This striking difference between both approaches can be attributed to differing compositions of lighting devices owned between household types (see Appendix Table C.C6): The proportion of households operating light bulbs is significantly higher among solar households in general and long-term SHS users with average differences between approx. 20 and 30 percentage points. Nevertheless, battery-powered lamps and solar torches seem to be the dominant lighting sources in otherwise unelectrified households, and solar households who could not maintain the functionality of their SHS seem to fall back on those lighting devices quite frequently. The AT estimates reinforce this pattern as the proportion of SHS users that additionally apply battery lamps or solar torches is relatively low. However, the data also suggests that

[56] Households mainly acquired mobile phones. The proportion of households that own mobile phones is 12 up to 20 percentage points higher among SCCDP and active SHS users and both groups maintain a significantly higher number of mobile phones (see Appendix Table C.C6). A few households bought electric ventilators. Other appliances like radios or TVs play only a subordinate role.

among solar households, having no lighting source at all is also a common condition, as the proportion of households with no lighting source (households that do not operate lightbulbs, battery lamps, or solar torches) in this subsample increases by 26 percentage points over the average if the SHS is still in use, further reinforcing the seemingly contradictory finding reported in Table 4.3.

Relating to health outcomes, we find a modest but consistent negative causal link between SHS usage (AT) and the prevalence of breathing problems in households. Although not statistically significant, the proportion of households with members suffering from breathing issues is approx. 5 percentage points lower among solar households. This difference increases to 7.7 percentage points and indicates statistical significance if the household still operates the SHS. However, based on the observed q-value we can only reject the hypothesis of a false positive result at the 10 percent level in this case (column 3 of Table 4.3). At the same time, the reduction in respiratory problems does not seem to translate into an improvement in self-perceived health status. Although insignificant the observed average effect in both specifications even goes in the opposite direction to what the finding regarding respiratory problems suggested.

The next set of outcomes provides evidence on whether solar households could profit from the electrification intervention concerning educational metrics. The average ITT effect of the SHS dissemination on daily study hours of children is positive and statistically significant. Children experienced an increase of 0.589 study hours (35 minutes). Again, among active SHS users (AT), the average treatment effect is noticeably larger in magnitude, sitting at 0.982 hours (59 minutes). The corresponding FDR q-value does not imply a false positive result in this case. The findings concerning the total number of study hours after nightfall provide a different picture however: Both reported point estimates are negative, while we observe a negative and significant treatment effect in the AT specification (0.26 hours or approx. 16 minutes) However, based on the corresponding q-value we cannot rule out the possibility of a false positive discovery regarding the AT in this case.

We find no statistically significant treatment effects regarding households' monthly expenditures per capita. While we observe an average positive treatment effect on stated life satisfaction, revolving around a 10% increase depending on whether ITT or AT estimates are taken into consideration, neither of those is statistically significant. There are also no noteworthy treatment effects to be reported regarding the feeling of security at night times.

Table 4.3 – Average Socioeconomic Treatment Effects

	ITT (1)	AT (2)	FDR q-value (3)
Total number of electric appliances owned	0.599*** [0.38, 0.819]	0.982*** [0.602, 1.363]	0.001
Total daily lighting hours	-0.058 [-0.689, 0.573]	-1.305*** [-1.948, -0.663]	0.001
HH member with breathing problems	-0.049 [-0.114, 0.015]	-0.077** [-0.152, -0.002]	0.071
Health status	-0.124 [-0.533, 0.285]	-0.204 [-0.696, 0.288]	0.384
Total daily study hours	0.589** [0.002, 1.176]	0.982*** [0.363, 1.6]	0.005
Total study hours after nightfall	-0.095 [-0.271, 0.081]	-0.262* [-0.564, 0.039]	0.11
Total monthly expenditures p.c. (log)	-0.003 [-0.138, 0.132]	0.008 [-0.163, 0.18]	0.792
Life satisfaction	0.089 [-0.365, 0.542]	0.114 [-0.321, 0.548]	0.532
Feeling of security at night	-0.04 [-1.192, 1.112]	0.004 [-1.057, 1.065]	0.792
n	744	404	

Note: We used different types of regression adjustment, depending on the scaling of the outcome variables to estimate the average treatment effect in the overlap. For a detailed description see section 4.3.3. Column (1) displays the average treatment effect in the overlap estimated from the sample disregarding the SHS's functionality status. Column (2) represents the average treatment effects in the overlap estimated among active SHS users, taking the SHS functionality status into account. Standard errors were clustered at the village level across all regressions. Column (3) provides adjusted p-values to control for the false discovery rate (FDR) and refers to outcomes in column (2). 95 % confidence interval in brackets. p<0.10*, p<0.05**, p<0.01***. Unweighted treatment estimations using regression adjustments are listed in Appendix Tables C.C7-C.C11.

4.3.2. Efficiency of the SHS Electrification Project

Based on the proceedings and assumptions described in chapter 4.2.4., Table 4.4 provides insight into the efficiency of the SHS dissemination in the context of the SCCDP. Subdivided into eight distinct scenarios, the table provides information on the scenarios' respective manufacturing country, CED totals for the solar panel (PV), LAB (based on the LAB weight and replacement rate), the cabling and charge controller (CC), as well as shipping of the aforementioned SHS components. The resulting total CED, as well as the reported E_{user} figures (identical throughout all scenarios), are highlighted as they form the direct basis for calculating the EPT in years as shown in formula (1). The results indicate that the SHS manufacturing country in fact only plays a relatively small role when comparing the respective CED totals between otherwise identical scenarios. Even under the most negative assumptions regarding LAB weight and replacement rates (scenarios 1 and 5), the total CED difference only amounts to approx. 112 MJ between SHS manufactured in China and Germany. Whether manufacturing country differences are mostly driven by the panel or LAB CED, as well as the impact of shipping differences, ultimately also depends strongly on the assumed LAB weights and replacement rates. Comparing the CED totals within manufacturing countries reveals the massive role of how the LAB are factored into the calculations: Between the worst- and best-case scenarios for each manufacturing country (scenarios 1 vs. 4 and 5 vs. 8 respectively), the higher LAB weight and replacement rates lead more than a doubling of the total CED figures. Naturally, this also translates into the corresponding EPT calculations. In the worst-case scenarios (1 and 5) households would need to use the SHS for around 14 years to outweigh the energy input into all SHS components. Corresponding to the previously discussed CED totals, in the best-case scenarios (4 and 8) the EPT would be cut in half.

Table 4.4 – Scenario-Based Energy Payback Time Calculations

Scenario	Manufacturing	CED PV (MJ)	LAB Weight (kg)	LAB Repl. Freq.	CED LAB (MJ)	CED CC (MJ)	CED Shipping (MJ)	**CED Total (MJ)**	Euser (kWh/year)	**Euser (MJ/year)**	**EPT (in years)**
1	China	363,03	7	10	1330	498	108,72	**2299,75**	21,80	**78,46**	**14,66**
2	China	363,03	2,5	10	475	498	39,05	**1375,08**	21,80	**78,46**	**8,76**
3	China	363,03	7	5	665	498	56,69	**1582,72**	21,80	**78,46**	**10,09**
4	China	363,03	2,5	5	237,5	498	21,72	**1120,25**	21,80	**78,46**	**7,14**
5	Germany	333,15	7	10	1260	498	96,64	**2187,79**	21,80	**78,46**	**13,94**
6	Germany	333,15	2,5	10	450	498	34,72	**1315,86**	21,80	**78,46**	**8,39**
7	Germany	333,15	7	5	630	498	50,39	**1511,54**	21,80	**78,46**	**9,63**
8	Germany	333,15	2,5	5	225	498	19,31	**1075,46**	21,80	**78,46**	**6,85**

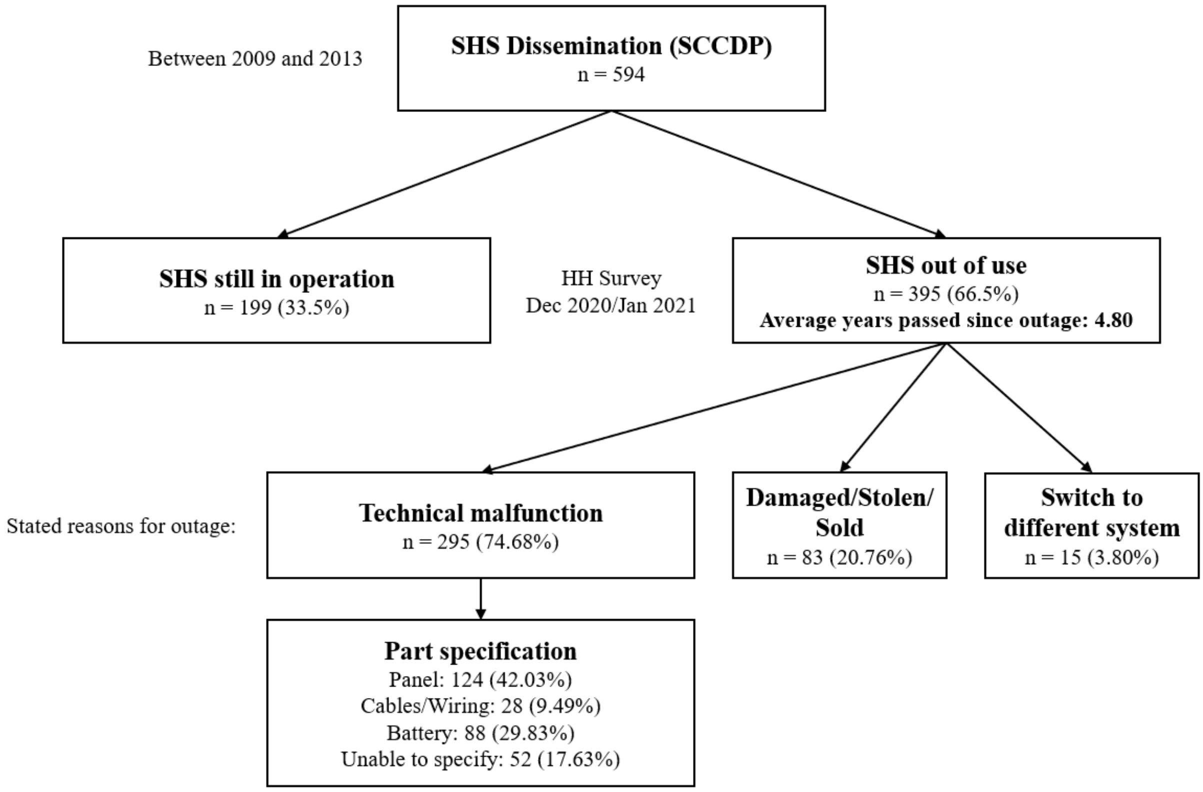
Note: All calculations are based on an assumed useful SHS lifetime of 20 years.

SCCDP household data on SHS maintenance and usage patterns allows us to draw conclusions on the overall efficiency of the rural electrification project investigated in this study. Figure 4.3 provides descriptive statistics on solar household responses about the current status of the SHS provided during the SCCDP in an illustrative manner. It should first be reiterated that against the context of our study, the higher LAB replacement rates (i.e., scenarios 1,2,5, and 6) are representative of what could be observed in the field and should therefore serve as the main benchmark against which observed runtimes should be compared. Out of the 594 solar households in our sample, only 199 (33.5%) reported still using the panel approx. one decade after the SCCDP dissemination. Out of these households, only 15.7% reported now using an alternative SHS comparable to the one provided during the SCCDP. Around 10.1% reported a grid connection to have replaced the SHS use, while the overwhelming majority of 70.9% reported only having battery-driven or solar torches as electric lighting sources, while 9.1% reported no electricity source at all. The main reported reasons for not using the SCCDP SHS anymore were technical malfunctions (74.7%) or damages to the SHS (13.2%). Based on this information alone, it can already be concluded that in 66.5% of cases, households were not able to reach SHS runtimes of at least 10 years. Among these households, the average amount of reported years since when the SHS was out of use at the time of the survey implementation was 4.8 years, with most outages reported to have occurred within the last six years (80.51%). It is noteworthy, however, that the data suggests a strong drop-off in outages in the two years before the survey as only 15.95% of all outages were reported within one year before the survey. This suggests that a large share of households was able to maintain their SHS for about five to six years, while about one-third of households were able to surpass this cutoff point.

When evaluating the efficiency of the SCCDP solar electrification project it must of course be taken into consideration that with a lower total runtime of the SHS, the calculated EPT also decreases significantly. This is due to the lower total of LABs that would be employed with the system in such cases, which, as the results in Table 4.4 clearly indicate, heavily affects EPT outcomes. One could thus argue that households with relatively SHS outages relatively shortly after the project's implementation should rather be benchmarked against scenarios with lower LAB replacement frequencies, which show significantly shorter EPTs, especially when heavy LABs are considered.[57] Still, for the large share of households that were not able to maintain their systems for more than five years, one would need to assume the most optimistic scenarios (e.g., only using light LABs with low replacement levels or only using one heavy LAB over the entire SHS lifetime) to potentially argue that households in such cases have reached EPT goals. Also, one needs to keep in mind that this would be considering the SHS having been used according to the simulation specifications in the first place. It is noteworthy however, that even considering worst-case scenarios, at least a third of households were seemingly able to maintain their SHS and as a result, were already coming close to reaching the efficient EPT at the time the survey was conducted.

[57] As the results in Table 4.4 suggest, depending on the manufacturing country, one heavy LAB equals about 0.91 (China) and 0.86 (Germany) years of EPT.

Figure 4.3 – Status of the SCCDP SHS at the Time of the Household Survey



4.4. Discussion

In line with previous findings on off-grid solar electrification in different socioeconomic contexts (Diallo & Moussa, 2020; Wagner et al., 2021), the findings from our quasi-experimental impact evaluation clearly show that the free dissemination of solar home systems during the SCCDP fueled the acquisition of electric appliances, irrespective of whether households were able to maintain the SHS until the time of our survey or not. More specifically, the solar households in our sample predominantly bought mobile phones, while a few were also enabled to acquire more power-demanding appliances like fans. The results suggest that within our study sample, the average solar household owns approximately one appliance more than a comparable control household. While the ITT results provide evidence that electricity is integrated into people's daily life in response to SHS exposure, the difference between ITT and AT estimates indicates that long-term effects on electricity uptake are also dependent on the functionality of the solar system. The large share of solar households reporting system malfunctions (see Figure 4.3) clearly challenges the project's long-term performance in achieving universal access to basic electric services and, in turn, the project's social sustainability, which is indicated by contrasts between ITT and AT estimates for other socioeconomic indicators.

Battery-powered and solar torches are incrementally substituted with light bulbs (see Appendix Table C.C6). This pattern is underpinned by the ITT estimates that indicate larger proportions of solar households switching back to portable lighting devices. The prominence of battery lamps and solar torches in combination with the absence of fuel-based lighting among study households diminishes the gains in lighting hours postulated by electrification literature (Lenz et al., 2017; Bensch et al., 2011; Grimm et al. 2017).[58] Especially households with active SHS at the time of the household survey report an average of 1.3 hours fewer lighting hours per day than control households. Our estimated effect has the same direction but is smaller in magnitude compared to Bensch et al. (2013), who report reductions in lighting hours of 2.5 hours per day when comparing households operating an SHS with controls that have access to battery lamps and torches. Battery-powered lamps and solar torches might be cheaper to run than lightbulbs fed by solar-generated electricity as suggested by Bensch et al. (2013) but also more convenient, as torches and lamps are portable. Particularly the SHS's limited capacity might create an urge to economize the available electric energy regarding the significant value households assign to mobile phones. Another striking explanation for our finding is the significantly larger proportion of solar households that do not apply any solar torches, battery-lamps, or lightbulbs at all. Unfortunately, we have no data at hand to directly evaluate the role of mobile phones in terms of lighting usage in our study context, since many mobile phones today are equipped with an LED torch, effectively replacing the need for traditional electric torches. It is therefore a clear possibility that we overestimate the effect of the SHS usage on daily lighting hours consumed. Cash constraints might incentivize some households to primarily purchase and maintain mobile phones instead of replacing light bulbs, and wiring, or needing to acquire (or pay) the required technical expertise to install the reparations and replacements.

Our data provide partial support for the hypothesis of positive health impacts on rural households after receiving basic access to electricity through SHS. While we find no effect on self-stated health perceptions, the prevalence of breathing problems is 7.7 percentage points lower among solar households when compared to controls in the AT specification. A lower incidence of respiratory diseases in women by age 16 was also reported by Samad et al. (2013). Closest to our results however are the findings reported by Chen et al. (2017), who are able to link SHS provision to a 9-percentage point reduction in the proportion of households reporting having experienced a cough within the past month. However, the socioeconomic settings of the mentioned studies are characterized by households' application of fuel-based lighting. As previously indicated, we do not observe comparable patterns regarding fuel-based lighting in our data at all. It should be pointed out however that NRSP clearly stated that households generally abandoned kerosene-powered lamps after the introduction of SHS. However,

[58] The proportion of households stating that they use oil or kerosene-powered and/or wick lamps ranges between 0.5% and 1.2% depending on the sample (ITT&AT).

alternative explanations are also conceivable: Families may have changed their social practices in response to the electricity provision and are now enabled to spend more time together (Wijayatunga & Attalage, 2005). In addition, families might substitute sitting close to firepits (and thereby being exposed to air pollution sources) with gatherings in illuminated rooms for joint private activities. Furthermore, mobile phones can provide quick access to health information and medical services (Lim et al., 2011).

The results of our analysis suggest a causal link between access to solar home systems and an increase in total study hours at home. While the estimated effect is in accordance with the results reported in the related literature, it is generally larger in magnitude (35 min – 59 min).[59] Point estimates range on comparable metrics only range between increases of 20 to 30 daily minutes spend studying per child (Bensch et al., 2013; Furukawa, 2014). Other studies report modest increases between 7 and 13 min per children's age group and gender (Grimm et al., 2017; Samad et al., 2013). Due to low enrollment rates in our study region and the resulting zero inflation of the dependent variable, we pooled the study hours for all enrolled children in the household, somewhat bloating our point estimates compared to other impacts like changes in study hours per child or age group.[60] Nevertheless, we cannot support the finding that an increase in study time at night or in the evening automatically drives a total rise in study hours (Bensch et al., 2013; Grimm et al., 2017; Samad et al., 2013). On the contrary, although not statistically significant, our estimates indicate a reduction in study time at night. The generally lower light consumption time among solar households could contribute to this finding. Also, even during dusk, well-illuminated rooms as provided through electric lightbulbs enable household members to conduct different activities simultaneously. Children can theoretically spend time doing homework, while parents engage in domestic activities and chores, which could ultimately explain a lower need for lighting hours during nighttime.

Our results provide no evidence for the impacts of solar systems on monthly expenditures. This is not surprising given the fact that effects on household expenditures reported in related studies manifest mostly via savings in energy expenditures, especially due to less spending on lighting fuel (Aklin et al., 2017; Grimm et al., 2017; Samad et al., 2013). We also find no evidence for increases in service provision, or income-generating activities like monetarized mobile charging among solar households (Wagner et al., 2021).

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[59] Although most studies concerning solar lighting technologies and their impacts report effects on study time, those findings are not universal. Other investigations on solar micro-grids or SHS find no evidence for changes in study patterns (Aklin et al., 2017; Chen et al., 2017).

[60] As explained in detail in section 3.2., the excess of zero observations in the educational outcomes and enrollment rates prevents us from calculating study hours per child as our level of analysis is the household. In addition, we cannot take a subsample of households with children in school without jeopardizing the balance of our quasi-randomized sample. However, the weighted average number of enrolled children among households that are able to send their children to school across solar and control households is 1.98 (1.95 ITT). A rough division of the average increases of 35 min (ITT) and 59 min (AT) by those numbers of enrolled children yields increases per child of 18 minutes (ITT) and 30min (AT). Those loosely and crude calculated results are much closer to impacts found in the respective literature.

Our findings regarding the environmental performance of the SCCDP solar electrification intervention, as proxied by the EPT calculations, are a clear reflection of the trends identified in related literature. As brought forward in both field and modeling studies, we provide clear evidence that the efficiency of SHS crucially depends on the types of batteries employed, as well as the battery replacement rates (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021; Ayeng'o et al., 2018; Diouf & Avis, 2019; Narayan et al., 2018). While the manufacturing country and the associated shipping distances of SHS components only play a negligible role in the EPT calculations of this case study, the EPT is extremely sensitive to the assumed size of the batteries to be used with the system, as well as the frequency of their replacement, reflecting issues commonly reported in related literature (Fuentes et al., 2018; Gustavsson & Mtonga, 2005). More widespread use of more efficient and environmentally friendly battery types instead of LABs, which represent the exclusive means of storing SHS-generated energy in our population of solar households, could greatly contribute to more realistically achievable efficiency goals.

Next to the widespread application of heavy LABs with relatively high replacement rates prevalent in our study sample, the other main contributing factor to the subpar overall efficiency performance of the SCCDP solar electrification project is the low amount of SHS that is still in use about one decade after dissemination. This leads to obvious issues relating to the project's efficiency, as EPT goals within the SCCDP can only be expected to be reached under the most optimistic assumptions. Our data does however suggest that the vast majority of SHS provided to solar households did not go out of use because more attractive alternatives became available, but due to technical issues the households were not able to fix themselves. In fact, our data suggests that among solar households that still operate an SHS (either the SCCDP provided or another one), about 65% of households stated confidence in being able to repair their SHS on their own. This reflects that the environmental performance of SHS-based electrification projects strongly depends on adequate proficiency among households to operate, maintain and/or even repair the systems themselves (Azimoh et al., 2014). Of course, this is directly dependent on the effort of implementing agencies in raising awareness or providing technical expertise to rural households. Even among solar households that were able to maintain the SCCDP SHS until the time of the household survey, only 75% of households indicated to have ever received some kind of maintenance with the system.

Finally, as illustrated in equation (1), the calculation of EPT crucially depends on the E_{user} calculations. In fact, a substantial efficiency problem in our case study stems from the fact that solar households just do not use the SHS enough. Even the relatively small 30W panels assumed for our study supply way more energy than the average household can even consume. As an example, already the relatively small increase from two light bulbs and two mobile phones to four of each would lead to a total 36% E_{user} increase, which would naturally drive the EPT down substantially. While an increase in electric household appliances would of course have no positive environmental impact, in combination with our findings on appliance uptake this consideration at least fuels our argument that SHS electrification interventions need to safeguard long-term appliance usage in order to justify their implementation in the first place.

4.5. Conclusion

While rural electrification projects employing small-scale solar technology are regarded as a crucial contributor to meeting the Sustainable Development Goal of universal electrification by the year 2030 (UNGA, 2015), literature on the long-term effectiveness, as well as the sustainability implications of such interventions is still surprisingly scarce. Relating to the social sustainability of such projects, only a handful of studies employ rigorous statistical methodology to make causal inferences, providing mixed results (Aklin et al., 2017; Grimm et al., 2017; Wagner et al., 2021). On the other hand, environmental scientists employ LCA methodology to investigate the environmental sustainability of SHS-based electrification projects (Antonanzas-Torres, Antonanzas, Blanco-Fernandez, et al., 2021; Sarker et al., 2020). While modeling studies within this strand of literature are able to provide a mostly optimistic outlook on the ecological viability of these types of interventions (Narayan et al., 2018), once observations from real-world case studies are taken into account, environmental problems, mostly related to the use of ecologically problematic battery technologies and subpar system maintenance, become more apparent (Azimoh et al., 2014; Sarker et al., 2020).

The study at hand provides insight into the long-term sustainability implications of a large-scale rural solar electrification project implemented in rural Sindh, Pakistan. We provide evidence on both the socioeconomic impact using state-of-the-art quasi-experimental methodology, as well as on efficiency considerations relating to the SHS dissemination rooted in LCA methodology. Our results indicate that both the socioeconomic impact, as well as the environmental performance of our solar electrification case study crucially depends on whether households were able (or enabled) to maintain the SHS provided to them over a timeframe of about ten years (between the SHS dissemination and our household survey). This is especially relevant as in the context of our case study, only about one-third of households can be classified into this group. Regarding the socioeconomic implications of the solar electrification intervention, we observe significant ITT effects on appliance ownership and study hours, while AT effects can be reported on appliance ownership, lighting, and study hours, as well as health outcomes. Effects on financial effects, life satisfaction, and feelings of security during the nighttime cannot be reported for either specification. Throughout, significant socioeconomic effects are larger in magnitude when the estimation is based on a sample specification that only takes such households into account, that were able to keep their SHS in use until the time of the household survey (AT).

Regarding the efficiency of the SHS dissemination as measured by EPT, we observe that among those households that were not able to maintain their SHS, about 70% were at least able to maintain them for five years or more. Still, even those households can only be expected to have reached the efficiency threshold as set per EPT when best-case scenarios are assumed, i.e., only the use of light LABs and low replacement rates. While the third of SCCDP beneficiary households that were in fact able to maintain their SHS until the time of survey implementation is close to reaching EPT thresholds even in the more realistic (worst-case) scenarios assumed for our analysis (heavy LABs with high replacement frequency), this positive note is dampened by the overarching caveat that all EPT calculations were conducted based on the optimal use and functioning of all modeled SHS components.

Our study enhances the literature on the socioeconomic impact of solar rural electrification projects by providing a positive affirmation of the technology's potential. Still, our findings regarding the long-term efficiency of such projects underline that significant portions of this potential are lost when the service provided in the follow-up is only of subpar quality, or even existent at all. Development policymakers should therefore not focus on the somewhat bleak outlook that this case study provides but more on the massive hidden potential that can be released if rural electrification projects using solar technology are implemented with a more hands-on and long-term perspective in mind. Naturally, our results on the socioeconomic impact of the SCCDP solar electrification project should be regarded with some caution due to the long observation period and reliance on quasi-experimental methodology only, while the EPT calculations are subject to a large array of assumptions. In the context of renewable technology dissemination to rural areas in low-income countries, future studies could therefore employ experimental methodology to investigate the effects of awareness/educational campaigns, as well as the provision of follow-up service in a more robust manner.

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Chapter 5 – How Rural Electrification Experiences Shape Sustainability Preferences - Experimental Evidence from Rural Pakistan

by

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Abstract: Solar electrification is generally regarded as an important puzzle piece in the push toward universal electrification. However, electrification initiatives in rural areas of low-income countries often disseminate solar home systems with questionable component quality, follow-up support to beneficiaries after the initial distribution phase is oftentimes lackluster and local markets are flooded with low-quality replacement products. Such problems are likely to reflect negatively on preferences for solar energy devices among new technology adopters, thereby hampering the long-term development of self-sustaining solar markets while potentially causing a disconnect with renewable energy systems among the rural population. A discrete choice experiment (n = 1,182) was conducted in rural Sindh, Pakistan to investigate how preferences for different solar home system characteristics, including two distinct sustainability labels, are affected by prior experience with such systems. Employing a between-subject design, additional experimental variation was introduced in the form of awareness video treatments to shed light on how such interventions can affect sustainability preferences in the short-term. While the results suggest positive average preferences for both sustainability labels, they indeed vary significantly with heterogenous personal experiences with solar home systems, highlighting potential problems relating to long-term sustainability outcomes of electricity infrastructure projects with subpar implementation and follow-up supervision.

Keywords: Rural electrification, Sustainability preferences, Awareness campaigns, Pakistan, Priming, Discrete choice experiment

5.1. Introduction

The lack of access to electric energy is widely regarded as a major impediment to socioeconomic development, affecting millions of people around the world (Pachauri et al., 2013). Based on recent figures, in 2020 still about 10 % of the world's population lacked access to electricity entirely (ESMAP, 2022). Considering only the world's rural population, this share even increases to 17.5%, while the numbers even suggest a slight upward trend in recent years (ESMAP, 2022). Among other factors, rural electrification is assumed to foster socioeconomic development mainly by enabling time savings and increasing productivity in rural households, as wells as through its positive impact on household health resulting from a reduced dependency on fossil-fueled indoor lighting sources (Cook, 2011). Acknowledging this potential, the United Nations declared 2012 the "International Year of Sustainable Energy for All" and defined the goal of universal global electrification to be achieved by the year 2030 (United Nations, 2011).

In achieving this goal, solar energy is expected to play a significant role. This stems from its dual appeal in being both relatively low-cost in production and dissemination, as well as its advantage of causing zero emissions in electricity production, especially when compared to the extension of fossil-fueled electricity grid lines to more remote and hardly accessible rural areas (Adenle, 2020). Rural solar electrification projects often disseminate some type of so-called Solar Home System (SHS) to rural households. Such systems typically consist of at least one solar panel, oftentimes a rechargeable battery, both of varying sizes and power capacities, as well as wiring to power small appliances as e.g., lamps, fans, or mobile phones (Wamukonya, 2007). One key question discussed in the academic literature surrounding is whether these types of projects can really deliver on the promise of fostering socioeconomic development. The last decade saw several studies on the socioeconomic impact of rural solar electrification projects, employing both experimental and quasi-experimental methodology to ensure robust causal inference. However, next to the differing identification methods, cultural contexts, dissemination modes, and the technical specifications of the distributed solar devices themselves, results are highly heterogenous throughout this strand of literature: Some studies find evidence for increases in nighttime studying hours (Bensch et al., 2013; Furukawa, 2014; Grimm et al., 2017), lowered expenditures for traditional fossil-based energy sources (Aklin et al., 2017), improved indoor air quality (Grimm et al., 2017) and higher perceived nighttime security (Bensch et al., 2013). However, these findings stand against a wide array of null results for other socioeconomic indicator variables reported in the same studies. Despite this somewhat mixed impression with regard to short-term[61] socioeconomic impacts, at least the majority of studies provide are able to provide positive evidence concerning the

[61] The evaluation period in the above-mentioned studies ranges between one and four years.

take-up of solar electricity among provided households (Aklin et al., 2017; Bensch et al., 2013; Grimm et al., 2017; Samad et al., 2013).

Apart from direct project impacts on socioeconomic development, one important aspect to safeguard positive long-term impacts and sustainability performance of rural solar electrification projects is the development of self-sustaining markets. Aside from an efficient initial program design and a functioning infrastructure of local entrepreneurs with technical expertise on the market supply side, the development of such markets requires positive user preferences for solar products on the demand side prices (Wakkee et al., 2014), especially when thinking beyond the initial project implementation phase, where products are often disseminated free of charge or at heavily subsidized prices (Newcombe & Ackom, 2017). Keeping the long-term implications in mind, the demand side of this dichotomy should optimally be characterized by consumers with an interest in products that promise a positive sustainability performance, which would be reflected in preferences for SHS with high-quality components that are reliable and do not require frequent costly maintenance. Apart from that, positive sustainability outcomes could also be triggered when consumers consider SHS models with a low ecological footprint. On both urban and rural consumer marketplaces, a product's adherence to safety and ecological sustainability criteria is typically reflected by quality labels or certificates (Mutersbaugh, 2005). In the context of rural solar electrification, given a certain label in fact does constitute a credible signal of quality, one crucial aspect for functioning and sustainable markets thus would be that potential consumers in fact have a positive preference for such a label, i.e., they would have a willingness to pay (WTP) for a product holding the label over a comparable product that does not. This is especially crucial as rural markets are typically characterized by uncertified low-quality products (Samarakoon, 2020).

The study presented in this paper tries to investigate consumer preferences for different SHS quality indicators in the context of a rural electrification project in southern Sindh, Pakistan. This is performed through the implementation of a discrete choice experiment (DCE) (n = 1,182), which was implemented between December 2020 to January 2021. The DCE confronts respondents with various hypothetical SHS purchasing situations. To specifically investigate the long-term sustainability implications of these preferences in line with the above line of argumentation, the study's analytical focus rests on the WTP for two SHS product labels, each reflecting a distinct dimension of sustainability preferences among rural consumers: One label focuses on the quality of the SHS product itself, reflecting mainly product safety and longevity. This label would mostly reflect the economic dimension of sustainability (Purvis et al., 2019). The other label included in the study design indicates a low ecological impact during the SHS production phase to the consumer, thus implicating a more straightforward and positive environmental impact of the product in question while reflecting the environmental or ecological dimension of sustainability (Purvis et al., 2019). Based on these considerations, the study first tries to answer the following research question:

R1: Do respondents state a positive preference for sustainability labels on SHS and do they differentiate between different dimensions of sustainability?

Another understudied aspect of solar electrification projects is how they affect perceptions and preferences of local people with regards to the solar products themselves, both in the short-term, but more crucially over a prolonged period of time, i.e., once first-time solar electricity users got accustomed to the novel technology and have adjusted their preferences in response to their individual and multi-faceted experiences with it. Following the assumption that individual preferences for solar devices respond to personal experiences with the technology, i.e., preferences are endogenous (Bowles, 1998; Mattauch & Hepburn, 2016), one would assume that they are also subject to how electrification projects are implemented and supervised after the initial dissemination phase. The literature indicates that off-grid solar electrification projects are oftentimes subject to severe issues relating to the quality of SHS components, especially regarding technical components aside from the solar panel itself, and that strict quality assurance is necessary to ensure sustainable development via solar electrification (Chowdhury & Mourshed, 2016). For solar electrification projects to effectively promote sustainable development, rural people should first be enabled to run their SHS and are then enabled to keep it up and running (or even upgrade it) after the initial dissemination period, preferably while using product components that surpass minimum quality and safety thresholds. Especially in rural and formerly unelectrified areas, which are typically characterized by low income and education levels, it is therefore crucial that new SHS users experience assistance after the initial dissemination phase of the electrification initiative. As certain SHS components are technologically complex and prone to malfunctioning, especially given the aforementioned quality concerns (Chowdhury & Mourshed, 2016; Groenewoudt et al., 2020), adequate training, monitoring, and follow-up support after the initial dissemination phase is an important puzzle piece (López-Vargas et al., 2021), as it affects the beneficiaries' perception of the product itself, which in turn is likely to affect future purchasing decisions. Should some of these aspects not be implemented to a satisfying degree, rural SHS users could become frustrated with solar energy and, e.g., deviate back to fossil-based energy sources or even become disengaged from partaking in future solar electrification endeavors altogether, reflecting negatively on long-term sustainability outcomes. The household survey during which the DCE was carried out, was part of a research project aimed at investigating the long-term socioeconomic impacts of rural solar electrification programs. Thus, owing to the impact evaluation design, households were sampled both from villages that received an SHS 8-10 years prior to the survey as part of a larger rural development program, as well as "control" households that were subject to another unrelated development intervention within the same project. This variation within the sample is exploited to tackle the second research question, which is related to experiences with the SHS, as well as the quality of these experiences:

R2: Are stated preferences for different SHS attributes (including sustainability labels) affected by prior experiences with solar systems and are those preferences affected by the quality of these experiences?

Finally, if the implementing actors behind solar electrification projects want to increase their sustainability outcomes, they could try to maximize the projects' potential by generating user awareness of solar energy's advantageous features regarding economic and ecological sustainability, especially in the early project stages. In socioeconomic development projects, awareness, information, or promotional campaigns are typically carried out by responsible development agencies or NGOs to bridge information gaps among rural populations about the merits of e.g., education, new medical products, hygiene, and/or the use of financial bookkeeping, but also about new technologies that can help them improve their lives and livelihoods (Banerjee et al., 2007; Biran et al., 2009). Relative to other development interventions, such information gaps play a specifically crucial role in the context of technology adoption (Bandiera & Rasul, 2006; Urpelainen & Yoon, 2015) and it has been shown that they also play a significant role in hampering a more widespread use of solar technology the context of solar electrification, either through a lack of knowledge about the technology itself (Rebane & Barham, 2011; Tillmans & Schweizer-Ries, 2011), or about questions relating to the purchase, maintenance, and use of the products (Azimoh et al., 2014; Friebe et al., 2013). Even if people are aware of electric energy and its usefulness in general, the concept of utilizing solar energy, let alone the fact that electricity consumers effectively become energy producers as well or even the technology's merits on a larger scale (zero carbon emissions in energy production in the context of global climate change) are likely difficult to comprehend for rural populations of low-income countries and hard to effectively bring across for development practitioners. While other studies have investigated the factors predicting awareness and adoption of SHS based on surveys (Abdullah et al., 2017; Rebane & Barham, 2011; Urpelainen & Yoon, 2015), this study tries to provide new experimental insight into how awareness can potentially affect preferences for certain SHS characteristics. Employing a between-subject design, a subset of the sample was exposed to three different types of awareness video treatments which comprised a neutral control video, as well as two treatment videos, each promoting information specific to the two sustainability labels. This setup allows us to shed light on the final research question:

R3: Are preferences for SHS sustainability labels affected by prior exposure to awareness-raising videos?

The findings suggest positive average preferences for both sustainability labels within the respondent sample, albeit the average WTP is highest for a warranty option on the SHS, even if this only protects against product malfunction for one year. Most notably, the results indicate substantial preference heterogeneity regarding SHS quality indicators (both sustainability labels and the warranty option) based on previous user experiences with SHS. While on average, SHS experience increases the stated WTP for said quality indicators, the data reveals that negative experiences, as reflected through technical product malfunction significantly dampen this effect. This observation, along with the fact that the reporting of technical issues with SHS was widespread in our sample, puts the long-term sustainability implications of rural electrification projects using solar technologies into question. This is further underlined by the finding that the awareness-raising videos did not seem to affect preferences for the sustainability labels in any systematic way. In sum, the study results suggest that agents concerned with the implementation of solar electrification projects in rural areas need to take the provision of long-term service and maintenance to newly connected households seriously if sustainable development objectives are supposed to be achieved in the long run.

5.2. Methodology

5.2.1. Discrete Choice Experiments and Sustainability Preferences

The method of choice to measure locals' sustainability preferences was to employ a DCE. The DCE methodology is rooted in random utility theory and experimental design (Hanley et al., 1998a). Typically, DCE respondents are put in multiple hypothetical situations in which they are asked to choose between two or more alternative products (or policy packages, etc.). These alternatives are characterized by multiple attributes, each with varying attribute levels between the selectable alternatives. The parameter estimates generated from DCE data can provide detailed information on respondent preferences for specific levels of the respective attributes, while the estimated coefficients can be used to infer WTP estimates for these levels. The DCE as an economic valuation method falls within the category of so-called stated preference approaches, which have the merit of enabling researchers to put an economic value on non-market goods such as e.g., environmental or cultural assets and, within the specific context of DCEs, also to investigate preferences for specific aspects of certain products or policy instruments (Bateman et al., 2013). Despite these advantages, stated preference approaches are put under scrutiny, most frequently relating to their purely hypothetical nature and the potentially resulting inflated WTP estimates - a phenomenon typically referred to as "hypothetical bias" (Hausman, 2012; Hensher, 2010). While numerous studies have explored ways to remedy the issue of hypothetical bias, e.g., by employing cheap talk scripts (Penn & Hu, 2019), within the context of this study, hypothetical bias is regarded as relatively unproblematic. This is because the WTP estimates resulting from the DCE in this study are not intended to directly inform future policy decisions e.g., relating to subsidized prices for

SHS but exclusively to compare the relative importance of certain attribute levels between each other and across different respondent groups.

Despite the drawbacks due to its hypothetical nature, the DCE methodology enjoys large popularity in various academic fields. Originating as ‘conjoint analysis’ in the early 1970s, at first, the method was frequently used in marketing and transport research (Green et al., 2001; Louviere & Woodworth, 1983). Since the early 1990s, its application has also become more popular amongst environmental scientists. As indicated above, this is due to its attractive properties in eliciting indirect and non-use values of specific attributes of, e.g., threatened ecosystems or animal species, as well as its many advantages over more direct stated preference valuation techniques such as the contingent valuation method (Adamowicz et al., 1994; Carson & Czajkowski, 2014; Hanley et al., 1998b). In recent years, stated preference techniques, including DCEs have also frequently been used to estimate consumer preferences and WTP for renewable energy (Ma et al., 2015; Soon & Ahmad, 2015; Sundt & Rehdanz, 2015) and product labels signaling certain sustainability standards (Bronnmann & Asche, 2017; Shen & Saijo, 2009). While this strand of literature almost exclusively relies on studies conducted in medium- to high-income countries and is therefore mostly concerned with the preferences of consumers who are in, or close to entering the process of a green energy transition, there is also a small number of studies concerned with eliciting such preferences among people in low-income countries (Abdullah et al., 2017; Abdullah & Jeanty, 2011; Aklin et al., 2016). Some even focus specifically on preferences related to SHS using DCE methodology. However, these studies investigate the social and technical factors explaining initial household adoption of SHS (Komatsu et al., 2013) or consumer WTP for specific technical attributes of the SHS itself (Graber et al., 2018) rather than exploring consumer preferences for sustainability aspects of SHS, which constitutes one of the main novelties of the study at hand.

5.2.2. A Discrete Choice Experiment to Measure Sustainability Preferences

The DCE was conducted as part of a larger household survey [62] (more information in subchapter 5.2.4. of the paper at hand) and was designed on the basis of two notions: Firstly, in contrast to the above-mentioned literature focusing on preferences regarding more technical attributes of SHS, one goal was to use the relative consumer popularity and familiarity with SHS in the study region as a vehicle to elicit

[62] The entire experimental protocol as employed during the DCE section of the survey in English with Urdu translations can be found in the Appendix (Appendix D.B1). The average total time to complete the survey was 51 minutes. Note here that the survey completion time varied substantially with the household electrification history, household size etc. as certain responses triggered additional sets of questions etc. Due to both practical and technical limitations, I do not have access to more precise information on the duration of the DCE section of the survey itself.

individual preferences for sustainability related to this type of product.[63] Secondly, through extensive expert interviews and focus group discussions in the research area, it became clear that rural people in the coastal areas of Sindh in fact have severe difficulties in understanding the technical specifications and complexities of a standard SHS, while also living under strict financial constraints in combination with low literacy rates. Thus, for the sake of simplicity and understandability, it was opted to fix the technical specifications of the SHS in the hypothetical purchasing situation and only vary the selectable options concerning the following attributes: the product's price, two different labels/certifications, each representing one distinct sustainability dimension, as well as two additional attributes related to product warranty and mode of payment for the product. The last two attributes are deemed as more significant and directly comprehensible to the respondent when compared to technical considerations which many respondents would likely not have been able to credibly verify themselves anyway.

After the respondents answered a catalog of questions on their households' electrification status, the field assistants initiated the experimental section of the interview by informing the respondents about the purely hypothetical nature of the DCE. In this context, they were asked to imagine being in a situation in which they were out to purchase a new SHS for their household. At first, the respondents were informed about the technical specifications and the additional attributes that characterize the SHS under consideration. An overview of the technical specifications of the SHS on offer within the DCE, as well as information on the attributes and their respective levels is provided in Table 5.1. Both, the technical aspects of the SHS, as well as all product attributes were conceived and developed under consideration of published literature (Abdullah et al., 2017; Aklin et al., 2017) but were mainly based on insights from a multitude of interviews and discussions with local villagers, representatives of NGOs active in solar dissemination projects in the study area, as well as local vendors of solar products, which all took place in February and March of 2019. Rural dwellers in the study area typically use a colloquial differentiation between "Chinese" (low quality and durability) and "German" (high quality and durability) solar systems as their main classification of quality with regard to solar products, which we applied in the experimental instructions.[64] Both, the battery, and the charge controller of the SHS were not specified further as they frequently are sold or distributed along with the SHS by default and, as with the panel

[63] The data collected in the household survey in which the DCE was embedded suggests a generally positive attitude towards SHS as energy sources with 86.2% of respondents fully agreeing to a Likert-scale item pertaining to the statement "A solar system is a good source of energy". The data also suggests a generally high degree of personal familiarity with solar devices: While 38.9% of the full sample indicated to use some form of solar electricity as their main source of lighting (ranging from solar torches to full solar mini grids and not including 230 observations (19.5% of full sample) who do not use the project panel anymore), 18.3% of all households indicated to be using solar torches as an addition to their main electricity source.

[64] Based on expert statements and personal experiences in the field, the market in the study area is in fact heavily characterized with wrongfully labelled products and a reasonable assessment of panel quality is virtually impossible for a person without in-depth technical knowledge. Still, I opted to label the DCE solar panel as "German" as people typically associate this classification with more high-quality and high-priced products. I also wanted to use a standardized SHS to minimize *a priori* negative connotations towards the product in question amongst respondents based on the experimental design.

itself, to avoid introducing any additional source for confusion among participants based on purely technical grounds. The final DCE design was pre-tested both in the study area as well as during a sister study on urban solar markets in Karachi.[65]

Table 5.1 – DCE product, attributes, and levels

<table>
<tr><td colspan="2">The solar home system you are looking to purchase consists of the following components:
- A 170 W poly crystalline “German/Germancell” solar panel
- A 12 V 100 AMP battery to store electric energy generated from the solar panel
- A charge controller to protect your battery from overcharging, which ensures a longer battery lifetime

All products feature the exact technical specifications listed above. However, they differ with regard to the following attributes and levels:</td></tr>
<tr><td>Attribute:</td><td>Levels:</td></tr>
<tr><td>The IFC Lighting Global certification</td><td>No certificate
Certificate</td></tr>
<tr><td>The Solar Scorecard certification</td><td>No certificate
Certificate</td></tr>
<tr><td>Full product/material warranty on all SHS components</td><td>None
6 months
1 year</td></tr>
<tr><td>Payment options (installments)</td><td>Direct payment
Two installments over six months
Three installments over one year</td></tr>
<tr><td>Total SHS price</td><td>Ranging between PRs. 14.000 – 26.000 in steps of 4.000 PRs.</td></tr>
</table>

As a standardized signal for product quality, I opted for a label based on a simplified version of the *International Finance Corporation* (IFC) “Lighting Global” initiative’s quality standards (Lighting Global, 2018). The IFC label represents a dimension of sustainability that is based on a product’s build quality, durability, ease of use maintenance, truthful advertising as well as health and safety concerns. Thus, products holding this label can be regarded as more sustainable relative to uncertified ones, mostly because they can be expected to feature significantly lower product failure and replacement rates due to technical malfunction or negative user experiences of other nature. The Solar Scorecard certification on the other hand was conceived from a simplified version of the *Silicon Valley Toxics Coalition* (SVTC) grading criteria for their Solar Scorecard program (Solar Scorecard, 2018). In contrast to the IFC label,

[65] The data collected in this study was used in a master thesis at the University of Marburg and has not been published in an academic journal.

this label is clearly intended to signal ecological sustainability in the product's manufacturing phase as e.g., reduced emissions in production, less use of toxic materials, reduction of water and electricity use during production, as well as ease of recyclability of SHS components.

Similar to what is reported in studies on rural solar markets in the Global South (Samarakoon, 2020), local vendors indicated during interviews that due to many low-quality products flooding the rural solar markets, people in the study area frequently ask for a warranty when buying an SHS or related product. Based on a high prevalence of financial constraints with income flows that are heavily influenced by seasonal harvest outcomes, potential consumers also frequently demand the possibility to pay in multiple installments, even though this possibility, just like the additional warranty, is more of an exception than the norm. Based on the popular demand and the participants' high familiarity with these concepts, it was concluded that both aspects would make suitable attributes for the DCE to balance out the sustainability indicators against attributes addressing the immediate financial needs of the respondents while creating hard tradeoffs between sustainability and pecuniary objective. While the warranty attribute ranged between no warranty and a year of full product warranty (illustrated by stylized labels), the installment attribute ranged between a one-time payment and a payment over three installments (illustrated by different amounts of pictures of a hand giving out money). Lastly, I varied the product's price between PRs. 14.000 and 26.000. A price range revolving around PRs. 20.000 was frequently indicated to be the average price for a "Germancell"-panel SHS around the time of the study.[66] The price attribute is also crucial for the interpretability of the DCE parameter estimates, as the price coefficients form the basis of the WTP estimates generated from DCE regression coefficients. Even though from a standpoint of external validity these estimates should always be taken with serious caution based on the hypothetical nature of the DCE methodology (Gutsche & Ziegler, 2019), they are helpful in interpreting and comparing the experimental outcome. Each attribute was explained by the assistants in detail and participants were reminded that they were free to ask questions at any time. Assistants were also instructed to point out the possibility to choose none of the alternatives in every choice situation, an option that is typically included in DCEs to more realistically mimic an individual's options in a given choice situation (Louviere & Woodworth, 1983).[67] After presenting an example choice card (Figure 5.1) to the participant and again clarifying any questions they might have, the experiment would start.

[66] During the time the DCE was conducted, 1 US$ was worth 160 PRs. Thus, 20,000 PRs. were worth about 125 US$.

[67] For a more detailed discussion on including a 'no choice' alternative see e.g., (Brazell et al., 2006).

Figure 5.1 – Example Choice Card

In order to reduce the number of choice cards presented to each participant, an orthogonal experimental design (Hanley et al., 1998b) was generated using the Ngene software.[68] Ngene generated a total of 36 choice sets (or choice cards) which the software split into six smaller designs, called blocks, of six cards each. This is done in order to reduce potential issues with participant fatigue.[69] Thus, each respondent was asked to answer six choice situations in total. Respondents were randomly assigned to one of the six blocks.

5.2.3. Video Treatment

Contrasting the traditional economist's paradigm of stable preferences across time and context, literature on endogenous preferences emphasizes the notion that preferences can be shaped directly by the socioeconomic environment (Bowles, 1998; Mattauch & Hepburn, 2016). In the last two decades,

[68] It was initially planned to run a full pilot study based on these orthogonal designs and then use the acquired estimates to generate a so-called d-efficient experimental design (Louviere et al., 2008), which can help in getting more precise parameter estimates (Yao et al., 2015). However, due to the outbreak of COVID-19, the field trip was cut short in March 2020, which unfortunately led to us having to stick with the original orthogonal design for the DCE presented in this study.

[69] The blocking procedure does ensure orthogonality with regards to the combination of all blocks, but not within each individual block. Blocking does however ensure attribute level balance within each block, i.e., respondents are not facing certain attribute levels more frequently than others (Holmes et al., 2017).

economists have increasingly tried to measure the causal impact of the environment on individual preferences by relying on priming techniques borrowed from experimental psychology. While there are many different types of behavioral primes, economic experiments typically use them to make specific concepts more salient and see how such primes affect a specific experimental outcome variable (Cohn & Maréchal, 2016). Primes related to sustainability have been shown to be effective in promoting more sustainable hypothetical consumer choices (Tate et al., 2014), however, there is limited evidence on how such primes function in a context characterized by low education and awareness on issues related to environmental sustainability.

In cooperation with the *National Rural Support Programme* (NRSP) and two academic research assistants proficient in Urdu, three different information videos were produced. The content of these videos was mimicking typical awareness-raising campaigns as carried out by NRSP in that it used both simple language and an easy-to-understand visual style. [70] All three videos were identical until approx. two minutes into the video. Until then, the video informed the participants about the general properties of an SHS, and how such systems can help improve rural lives from different socioeconomic perspectives. In the first group, from now on referred to as the control video group, the video ended at this point and the enumerator began with the DCE instructions as outlined in chapter 5.2.2. However, in the first treatment group, the video continued with information directly catering to the properties of the IFC Lighting Global label, while in the other treatment group, the video went on with information pertaining to the SVTC Solar Scorecard label. Those two groups will henceforth be referred to as the IFC and the SVTC video group respectively. Both treatment videos were about one minute longer than the two-minute video in the control group. The exact wording used in the three different video versions can be found in the video scripts in Appendix section D.C, along with a few exemplary screenshots from the videos.

5.2.4. Study Context and Sampling

The DCE was conducted in the context of a larger household survey aimed at investigating the long-term socioeconomic impacts as well as the ecological performance of a large-scale rural electrification project using SHS. Household surveys were carried out for 30 days between December 2020 and January 2021. The project in question, the *Sindh Coastal Community Development Project* (SCCDP), was funded by the *Asian Development Bank,* and development interventions were carried out in the rural coastal areas of the Sindh province in southern Pakistan between 2008 and 2014. Implemented in the field by the NRSP, the SCCDP rolled out a plethora of different interventions to the local population

[70] NRSP field officers showed us illustration materials from different awareness raising campaigns they conducted in the study area. The videos used graphical illustrations and pictograms inspired by the graphical presentations style used in these materials.

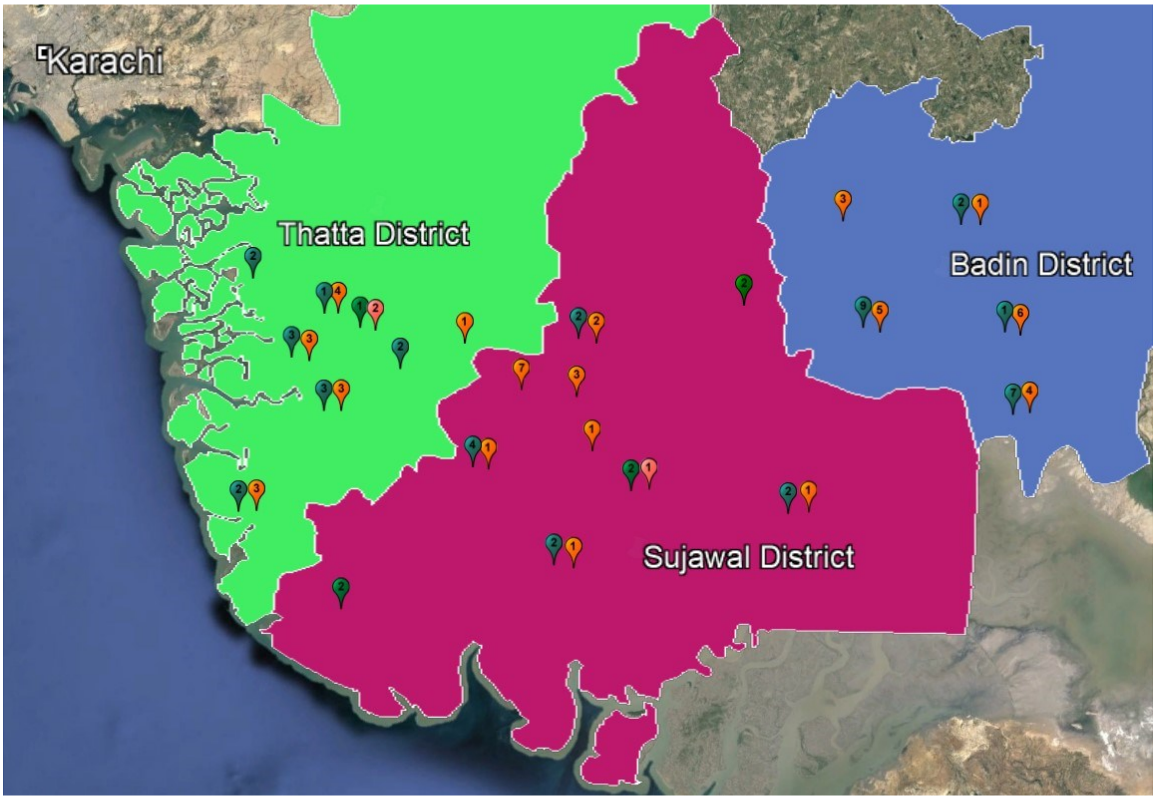
including measures related to water and sanitation (e.g., household water supply & toilets), education (e.g., renovation and construction of schooling facilities), transport (e.g., roads & bridges), microfinance and energy (Asian Development Bank, 2014).[71] Given the thematic context of the research project in which the household survey was implemented, the main intervention of interest was the dissemination of 4,515 solar panels, which were allocated to a total of 190 villages among the three districts Thatta, Sujawal, and Badin.[72] These 30W polycrystalline panels were distributed to rural households along with a charge controller (12V, 1 AMP) and a battery (12V, 17AMP), three 5V light bulbs, and a charger for mobile phones.

Village and household sampling was thus based on considerations fitting a quasi-experimental socioeconomic impact evaluation using propensity score matching based on village data that was gathered by NRSP during the SCCDP implementation phase. Specifically, the on-site team surveyed a total of 98 villages which were randomly sampled from an original list of 408 villages. The villages included in the original list differed with regards to the intervention they received during SCCDP: 186 of the villages were provided with solar panels, which from here on will be referred to as 'solar' villages, while the remaining 222 villages, from here on 'control' villages, received basic sanitation facilities.[73] From these lists, 60 solar and 60 control villages were randomly sampled. After a seven-day period of enumerator training and final pre-tests, enumerator teams (consisting of 5-6 persons) were instructed to visit 1-2 villages per day based on the population size of the visited village and logistical convenience for a total of 30 days, while alternating between solar and control villages to ensure balance regarding experimental group sizes. Enumerators were paid at daily rates and not per completed survey in order to disincentivize them from rushing through surveys and they were only asked to complete 3-4 surveys per day on average. As a result, the number of households interviewed per village ranges between 5 and 17, with the average amount of households per village sitting at 12.1. In both village types, enumerators were instructed to sample households according to a random walk procedure, while in solar villages, enumerators were specifically instructed to only interview households that indicated to have received an SHS during the SCCDP project. In total, 98 of the 120 randomly sampled villages were visited (equally split across both village types). This procedure resulted in a sample of 1,203 surveyed households (599 solar and 604 control households) of which a total of six from the solar group were dropped due to a wrongful household classification by the enumerators.[74] Another 15 observations were excluded from the analysis because the total survey duration exceeded the average by more than two

[71] The total amount disbursed to the SCCDP was US$ 36 million (Asian Development Bank, 2014).
[72] Note that during the majority of SCCDP implementation, the Sujawal district still belonged to the Thatta district, which was split to form the new Sujawal district in October 2013.
[73] It was opted to go for this differentiation between village types because the baseline data did not include information on villages that received no intervention in SCCDP at all – thus the study lacks a 'proper' control group for a quasi-experimental causal inference.
[74] These households were situated in SCCDP provided villages and were sampled based on the fact that they had received a SHS during the project. However, going through specific control questions revealed that they were not provided after all, leading us to drop those observations altogether.

standard deviations resulting in a final sample size of 1,182 (595 solar and 587 control villages).[75] The geographical distribution of sampled villages is illustrated in Figure 5.2.

Figure 5.2 – Map Illustrating the Sampled Villages by Union Council



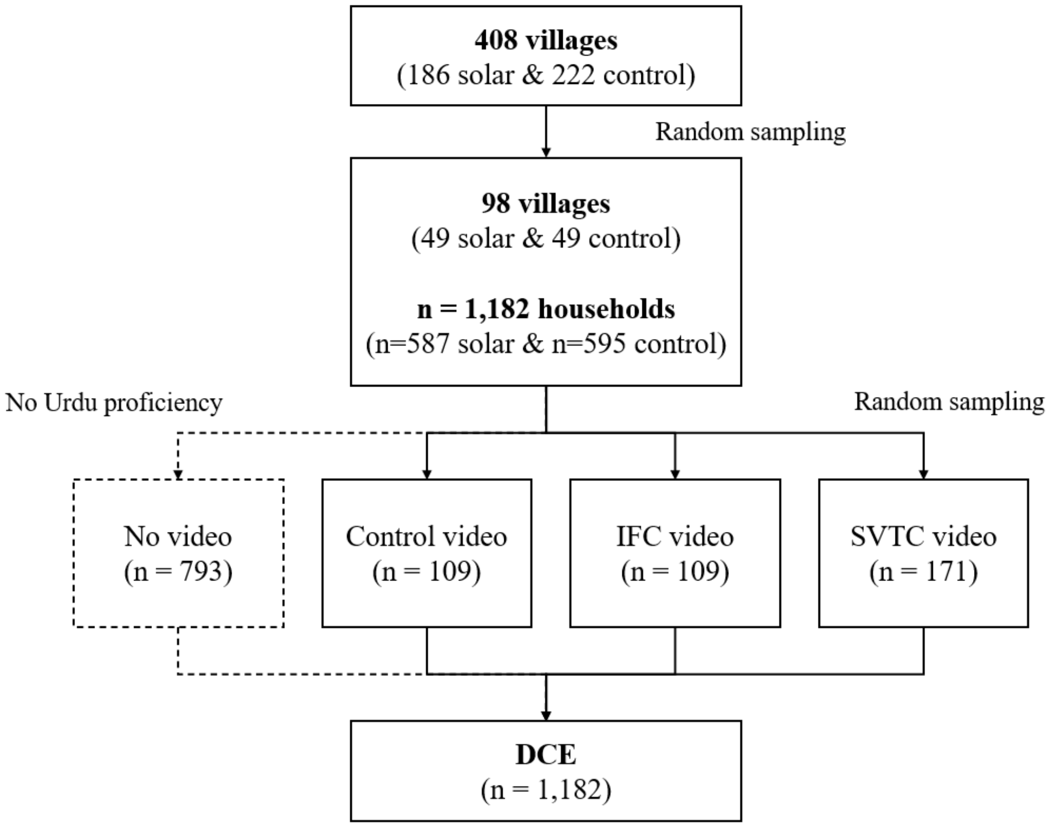
Note: The map highlights the three sampling districts located in the coastal region southeast of Karachi. The number of solar villages sampled within a union council is given in the green pins. The red pins contain the corresponding number for the control villages.

With regards to the DCE analysis, the differentiation between village types will be used as one of the main control variables, indicating heterogenous previous exposure to solar electrification. This part of the analysis will be enhanced by information on household satisfaction with previous SHS experiences which was collected during the household surveys. Sampling into one of the three video treatment groups was randomized between all respondents, irrespective of the type of the respective village. However, videos were produced in Urdu language and therefore only respondents with proficiency in

[75] I attribute these extreme values to input mistakes, where enumerators missed to finalize a form, e.g., at the end of the working day and then finalizing it on the next day. As I cannot be sure about this however, I opted to exclude these observations for the sake of cautiousness. Two standard deviations above the mean corresponds to approx. five hours of interview time with the distribution starting to show extreme gaps above this value. To exclude these extremes, I opted to even go below the three-sigma rule of thumb (i.e., excluding outliers three standard deviations +- the mean).

Urdu were exposed to the videos.[76] Thus, while all 1,182 respondents participated in the DCE, only 389 were subject to the video treatment variation (109 in the control video group, 109 in the IFC video group, and 171 in the SVTC video group). While this has the obvious downside of losing about two-thirds of the sample for investigating heterogenous responses to the different video treatment variations, it enables the analysis of exposure to the videos against a large number of respondents who did not see a video at all. Thereby, I am not only able to investigate the effects of the two label information treatments (albeit at lower statistical power) but also an overall potential effect of awareness through watching the video. An overview of the sampling procedure is given in Figure 5.3.

Figure 5.3 – DCE Sampling Procedure



[76] In large parts of the rural areas in Sindh, people only speak Sindhi language or other minor tribal dialects. All employed enumerators were proficient in Urdu, Sindhi and English and thus had no problem to explain different parts of the survey, as e.g., the DCE and its components to the respondents. The videos were produced in Urdu with an even larger sample in mind: it was initially planned to conduct a similar experiment in the Karachi suburbs, where solar electricity is growing in popularity and households use it to equip themselves against frequent power outages. However, due to the outbreak of the COVID-19 pandemic and the 2020 Karachi floods, the majority of this research, including the video experiment, had to be delayed indefinitely and ultimately cancelled.

5.2.5. Descriptive Sample Statistics

Table 5.2 provides general socioeconomic information on the experimental sample and outcomes of additional key survey items between village types. Next to the variables indicating the DCE attribute levels, these variables do represent the main set of control variables, which are employed throughout the analysis both for answering the research questions formulated above, as well as to investigate preference heterogeneity between different respondent groups. The household heads, who were always asked to be the primary respondent to the survey, including the DCE, on average were 44.85 years old, stated to have completed an average of 2.17 years of formal education, and featured a literacy rate of 31%. The average household size in the sample was 8.64 people including the household head, while average monthly household expenses averaged 23,520 PRs. [77] [78] The average household head rated its overall household health at 1.11 on a Likert-scale ranging from -2 (very bad) to 2 (very good). Sampled households had an overall good opinion on electricity benefits in general, and on solar electricity specifically. The "new environmental paradigm" (NEP) (Dunlap & Van Liere, 1978) figures are based on and averaged over three scale-statements that were selected based on pre-tests and expert interviews.[79] With an average agreement to NEP statements of 1.47, sampled households exhibit generally high stated environmental preferences. Finally, household heads were asked for their overall life satisfaction, which averaged 1.28. There are imbalances between both village types to be addressed, especially relating to the educational outcomes: On average, household heads in the solar villages reported 0.95 fewer years of schooling, and literacy rates were 10% lower. These differences can most likely be explained by differences in the geographical situation between village types: The dissemination of SHS within the SCCDP was not randomized and certain villages were preferred for solar electrification because they were regarded to be less likely to be connected to the electricity grid at some point due to their remote location.[80] While no information on the distance to the nearest school was collected during the survey, it is likely that this remoteness is also positively correlated with lower access

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[77] I am able to compare the figures regarding household size and literacy rate with figures from the most recent general population census in Sindh, which took place in 1998. Male literacy rates were at 31.58% and 35.07% in Thatta and Badin districts respectively, while the respective average household sizes per district were at 5.1 and 5.3. While the surveyed literacy rates are quite close to the census figures, average household size in the sample is about 3.5 people larger. However, the increase in household size is in line with Pakistan's overall population growth from 1998 to 2020 (about 65%) at about 70% (https://www.macrotrends.net/countries/PAK/pakistan/population-growth-rate). Thus, it can be assumed that the sample reflects the general population in the three study districts reasonably well.

[78] Monthly expenses were partly inferred from annual figures. In total, this figure is composed of monthly expenses on foods and drinks, transportation, medical products and mobile phone top-up and yearly expenses on hospital visits and household repairs, each divided by 12 months.

[79] NEP statements were pre-selected from the full set of statements based on understandability and relevance for the study context. The three statements chosen were "the balance of nature is easily upset"; "humans have the right to modify nature to suit their needs" and "when humans interfere with nature, it often leads to disastrous consequences". Agreement to the second statement was inverted, so the reported averages are based on a scale from "negative" to "positive" from the perspective of environmental preferences.

[80] Solar villages on average are located 4.60 km away from the nearest asphalt road – 1.97 km further than the average control village (ttest p-value = 0.00).

to educational facilities. While it is likely that the lower educational levels among solar households have affected the DCE responses to at least some degree, as indicated above additional analysis in which the variables listed in Table 5.2 are used as controls is also provided to address this issue.

Table 5.2 – Descriptive Sample Statistics

VARIABLES	n	mean	sd	min	max	difference solar - control
age of hh head	1,182	44.86	11.476	15	84	0.929
hh head years of education	1,182	2.167	3.816	0	15	-0.950***
hh head able to read and/or write?	1,181	.308	.462	0	1	-0.104***
no. of people living in hh	1,182	8.625	4.068	1	20	0.690***
monthly hh expenses (in 1,000 PRs)	1,182	23.473	19.508	0.667	210.583	0.434
stated hh health assessment	1,182	1.111	1.040	-2	2	-0.061
“communities can benefit from electricity”	1,165	1.639	.808	-2	2	-0.033
“solar system is good source of electricity”	1,178	1.818	.532	-2	2	0.024
NEP	1,101	1.469	.720	-.667	2	-0.026
stated overall life satisfaction	1,180	1.286	.962	-2	2	-0.028

5.3. Empirical Strategy

The basis for the econometric analysis employed in this paper is the data collected in the DCE, which was described in detail in the previous subchapter. Within this DCE, each participant *i* was confronted with a set of $M = 6$ hypothetical purchasing situations in which they were asked to state their preferred choice between $J = 3$ alternative SHS. Each of these SHS was characterized by a total of five attributes, which were held constant between choice alternatives, while the respective attribute levels varied between the alternatives (see Table 5.1 and Figure 5.1). To examine the effects of said attributes on the choice between different hypothetical SHS, I rely on multinomial discrete choice models (Gutsche & Ziegler, 2019), which assume individual utility functions for each choice alternative within a choice situation. Thus, a respondent's (i) utility (U) for each alternative (j) in a given choice set *m* ($m = 1,\ldots,6$) can be described by:

$$U_{ijm} = \beta_i' x_{ijm} + \varepsilon_{ijm}$$

where Utility U_{ijm} depends on a vector of unknown parameters β_i, as well as the vector of explanatory variables x_{ijm}, which captures the explanatory variables based on the SHS attributes (as described in Table 5.1) and explanatory respondent characteristics (as listed in Table 5.2). Any unobserved factors affecting respondent i's choice for an alternative j in a given choice situation m is captured in the error term ε_{ijm}. Additionally, to investigate potential experimental treatment effects, as well as potential effects of the additional explanatory and control variables as listed in Table 5.2, I introduce interaction terms between these variables and the variables on SHS attributes. For the main analysis of the DCE, I employ simulated maximum likelihood estimation of mixed logit models (Hensher & Greene, 2003; Mcfadden & Train, 2000). I opt for this approach over the use of common multinomial logit models, as mixed logit models do not rely on the restrictive independence of irrelevant alternatives property (Hoyos, 2010; McFadden, 1973), allow for taste heterogeneity between participants, and are able to capture unobserved correlations between choice alternatives in a choice set (Gutsche & Ziegler, 2019). In line with the practice established in related studies (Goett et al., 2000; Hensher et al., 2005) the parameters associated with financial attributes (in this case, the SHS purchase price, as well as the mode of payment), the warranty options, as well as all interaction terms are specified as fixed, whereas attributes with no direct relation to financial interests (both sustainability labels) are specified as random parameters. For all mixed logit model estimations in the WTP space, which are reported in this paper, I use the Stata commands *mixlogitwtp* (Hole, 2016). In this method, WTP distributions are already specified at the estimation stage and are not calculated based on coefficient ratios estimated in the preference space post-estimation. Differences in model fit between mixed logit estimations in the preference space and WTP space have been shown to be marginal, while the outcomes of WTP space estimations provide more conservative WTP estimates and have the additional merit that the coefficients can be interpreted more intuitively (Hole & Kolstad, 2012). The generated coefficients in the WTP space are estimated on the basis of the SHS price attribute and can therefore be directly interpreted in PRs. For each model presented in the main paper, an identically specified model in the preference space is given in the Appendix (section D.A). These were estimated using the *mixlogit* (Hole, 2007) command and also allowed for the use of robust standard errors clustered at the village level.[81] For all model estimations both in the WTP, as well as in the preference space, R = 1000 Halton draws were used (Ellis et al., 2019).

Answering the research questions stated in the introduction relies on investigating the preference heterogeneity for the different SHS attributes among different populations, i.e., rural people with different exposure to and experiences with SHS that also differ with regard to their individual

[81] Therefore, the mixed logit estimations in the preference space that are reported throughout the Appendix can mainly be regarded as a robustness check based on the application of clustered standard errors at the village level. It is reasonable to account for village-level variation in this manner as the development interventions within SCCDP were also disseminated at the village level and observations can therefore not be regarded as fully independent within villages.

socioeconomic backgrounds and characteristics. I approach the investigation of potential preference heterogeneity between participant groups in two different ways: First, as indicated above, I estimate mixed logit models with interaction terms between the SHS attribute variables and indicator variables for the subsample characteristics of interest. However, while this type of model allows for taste heterogeneity between respondents, it is included based on specific assumptions about the continuous parameter distribution (Gutsche & Ziegler, 2019), while it is argued that taste heterogeneity should rather be regarded as discrete (Adamowicz et al., 2011), e.g., in cases where certain respondent groups systematically state a higher preference (and thus WTP) for specific SHS characteristics. Therefore, secondly, I employ an additional analysis of preference heterogeneity between participant groups by using latent class logit models. These models are useful in tackling the issues mentioned above, as they assume discrete mixing distribution, allowing parameter heterogeneity to be explained by individual participant characteristics (Greene & Hensher, 2003). The additional use of latent class logit models is also helpful in that their application does not require financial explanatory variables to be assumed as fixed. Latent class logit models are based on the assumption that respondents are implicitly assigned to respondent groups, or classes. The quantity Q of these classes is pre-specified by the researcher. Firstly, the probability of a respondent choosing a specific SHS in a particular situation, given that they belong to a specific respondent class q ($q = 1, \ldots, Q$), is estimated. The probabilistic assignment to a specific respondent class q then follows the estimation of a so-called membership model. Here, class membership depends on a vector of variables describing individual respondent characteristics (in the case of this study, the variables listed in Table 5.2). I employ latent class logit model analysis by using the Stata command *lclogit* (Pacifico & Yoo, 2013), which is based on the expectation-maximization algorithm following (Train, 2009).

5.4. Results and Discussion

5.4.1. Preferences for Different SHS Attributes

Table 5.3 model (1) reports the DCE results for the full sample. The results are based on including all n = 1,182 participants, irrespective of whether they were exposed to the video treatment or not. Model (2) reported in Table 5.3 drops observations that were subject to the video treatment.[82] Throughout, the parameter estimates are reported for the choice among three distinct SHS, as introduced in the methodology chapter 5.2. Each observation in Table 5.3 (n = 21,144) represents a binary choice for or against one SHS in a given choice set that is characterized by varying attribute levels. Random parameter standard deviations are significantly from zero throughout both model outcomes shown in Table 5.2.

[82] It was opted to provide this alternative specification for all models shown in this paper, due to the fact that the video intervention had a significant average effect on respondent preferences for a multitude of attributes (see chapter 5.4.4 for more details on this).

This indicates high degrees of unobserved heterogeneity between participants regarding their preferences for these attributes (Gutsche & Ziegler, 2019). As expected, the price parameter shows a significant and negative coefficient, implicating a preference for lower-priced SHS within the sample. Furthermore, it can be observed that the average respondent indeed exhibits a positive and significant preference for both sustainability label types.

Result 1.1: On average, the sample population has a positive and significant preference for both types of sustainability labels.

However, it can clearly be observed that the WTP estimates for both sustainability labels differ in both models reported in Table 5.3, in that the average WTP appears to be higher for the IFC than the SVTC label. Whereas the average respondent states a willingness to pay an additional 16,992 to 24,620 PRs. for an SHS that does feature the IFC label over an alternative SHS that does not, the corresponding figures for the SVTC label only range between 12,083 and 16,130 PRs.

Result 1.2: Respondents do differentiate between both investigated sustainability dimensions: Relative to the SVTC label, average preferences are higher for the IFC label.

With the respondents facing a trade-off between two different types of sustainability indicators, as represented by the two sustainability labels within the DCE, higher average respondent preferences for a label signaling economic sustainability over a label signaling ecological sustainability are probably not too surprising. Related studies show that rural household preferences for SHS are strongly affected by variations in household income (Komatsu et al., 2011; Urpelainen & Yoon, 2015). While in theory both SHS labels can incur a positive impact on household finances in the long run, among both labels, the IFC label undoubtedly is the one signaling more immediate positive economic potential to rural households, in that it advertises lower product failure and replacement rates, which can lead to positive financial outcomes in a matter of only a few years.

The coefficient estimates apart from the two sustainability labels also show the expected direction: both warranty types are preferred over an SHS having no warranty at all. In fact, the respondents exhibit the highest WTP among all attribute levels for the SHS having a full one-year warranty. Both installment types are preferred over direct payment, even though the WTP differs only slightly between the two and three installment options. Still, this underlines the above-stated notion of financial constraints playing a significant role in choosing an SHS. The full warranty attribute level however is clearly preferred over the medium option, with the average WTP for the full one-year warranty exceeding the six-month option by more than 12,000 PRs in both models reported in Table 5.3. Thus, while preferences for both sustainability labels are positive and significant both statistically and economically, the rural population in the study sample still clearly prefers more traditional securities like warranties over such labels. While the demand for formal insurance against financial losses can surely be regarded as a crucial factor behind this finding, it might also be related to the lack of familiarity with the sustainability labels or a lack of trust towards the labeling institutions themselves. Identically specified regression models estimated in the preference space with robust standard errors clustered at the village level are reported in Appendix Table D.A1.

Table 5.3 – Main DCE Results in WTP Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

	(1)		(2)	
VARIABLES	Parameter means	Standard deviations of parameter estimates	Parameter means	Standard deviations of parameter estimates
SHS price in 1000 Pakistani Rs	-3.130***	1.236***	-3.459***	1.309***
	(0.089)	(0.083)	(0.131)	(0.116)
IFC label	16.992***	16.777***	24.620***	19.999***
	(1.551)	(1.478)	(3.184)	(2.656)
SVTC label	12.083***	10.087***	16.130***	-11.092***
	(1.075)	(0.998)	(2.178)	(1.798)
Six months warranty	15.667***		23.532***	
	(1.432)		(3.225)	
One year warranty	27.871***		38.914***	
	(2.328)		(5.063)	
Two installment payments	9.725***		11.650***	
	(0.970)		(1.835)	
Three installment payments	10.943***		12.193***	
	(0.860)		(2.053)	
n	21,144	21,144	14,190	14,190
Video treatment included	YES	YES	NO	NO

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory dummy variables reflect respective attribute levels. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=1,182 participants (n=792 with video intervention excluded) and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

5.4.2. SHS Attributes and Respondent Characteristics

Table 5.4 displays mixed logit estimation results based on model specifications identical to the ones reported in Table 5.3, however with additional interaction terms to gain a first insight into how different socioeconomic characteristics, as well as stated attitudes to (solar) electricity and sustainability, might affect preferences for SHS attributes as specified within the DCE. With regards to this part of the analysis, I first put my focus on the two sustainability labels: Model (1) of Table 5.4 displays how preferences for the IFC label interact with the different socioeconomic covariates as listed in Table 5.2. It can be observed that an increase in household size significantly explains parts of the overall preference for the IFC label (p-value < 0.05), as does an increase in stated monthly household expenses and a higher appreciation for electricity benefits in general (both p-value < 0.1). While the latter of these two effects are intuitive when considering the roles of price sensitivity in green consumption in general (Yue et al., 2020), and with regards to sustainability labels specifically (Sundt & Rehdanz, 2015), as well as the role of credit constraints prevalent in the Pakistani SHS market (Abdullah et al., 2017), the first one does not seem as interpretable in a straightforward manner. However, here one should keep in mind the sampling imbalances regarding household sizes reported in Table 5.2, indicating that significant interactions with this variable are potentially affected by the heterogeneity in exposure to SHS between experimental groups, which will be explored further in the following subchapter.

Interestingly, a higher score on the NEP scale significantly goes along with a lower stated preference for the IFC label (p-value < 0.01). At first glance, as the IFC label and its descriptions as part of the DCE instructions did not address a direct ecological understanding of sustainability as represented by the NEP statements, this result is probably not too surprising. In fact, it can be assumed that in situations where respondents faced a tradeoff between both sustainability labels, those that stated higher sustainability preferences, as represented by a high score on the NEP scale, were more likely to reject the IFC label in favor of the SVTC label due to its ecological focus. When looking at the coefficient estimates reported in model (2) of Table 5.4, where socioeconomic indicator variables were interacted with a dummy indicator for an SHS featuring the SVTC label, this notion is at least partly confirmed: There is a positive and significant interaction (albeit only at the 10%-significance level) between preferences for the SVTC label and a higher score on the NEP scale, accounting for a total WTP of 2.076 PRs per one-point increase of individual NEP score. This reflects the notion that higher stated environmental values (e.g., in this case, measured via the NEP scale items) predict increased pro-environmental preferences as reflected in, e.g., choosing an ecological label over alternative quality indicators (Cordano et al., 2010; Tanner et al., 2021; Yi, 2019). As with the IFC label, a higher stated WTP for the SVTC label is positively and intuitively associated with an increased appreciation of electric energy, as well as monthly household expenses (p-values < 0.05). All of these effects are robust to identically specified model estimations in the preference space with clustered standard errors, as well as estimations excluding respondents that were subjected to the video treatment (see Appendix Tables

D.A2 – D.A4). Within the subgroup of respondents that did not see any of the experimental videos, a positive interaction between preferences for both sustainability labels and a higher appreciation of solar energy can be observed, already indicating some of the preference heterogeneity induced by exposure to the video, which will be discussed in a more detailed fashion in subchapter 4.4.

The estimation results reported in column (3) of Table 5.4 reveal significant preference heterogeneity for the highest SHS warranty level based on the household head's years of education, literacy, as well as household size. However, none of these effects is robust to alternative model specifications as shown in Appendix Tables D.A2 – D.A4. There is however a robust and significant positive interaction between a higher score on the NEP scale and preferences for the highest SHS warranty (p-value < 0.01). A potential explanation for this finding can be found in the previously discussed contrasting relationship between the NEP score and preferences for the two sustainability labels, as well as the conceptional overlap between the IFC label and the SHS product warranty: In cases where respondents preferred the SVTC over the IFC label, they might have wanted to reassure their hypothetical purchase with a product warranty. Respondents that were more interested in the IFC label on the other hand, in many cases might not have felt the need to acquire an additional warranty if the IFC label already provides them with a level of security against product malfunction. Column (4) of Table 5.4 provides coefficient estimates based on the inclusion of interaction terms between preferences for three installment payments and the established socioeconomic indicator variables. Here, the only significant and robust interaction that can be observed is a negative relationship between household expenses and preferences for three installment payments to acquire the SHS (p-value < 0.01). This is intuitive, as more financially constrained households can use installment plans to make purchases that would prove too costly to pay straight away.

Table 5.4 – Respondent Characteristics and Label Preferences in WTP Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

	(1)		(2)		(3)		(4)	
VARIABLES	**Interaction w/ IFC label**	Standard deviation	**Interaction w/ SVTC label**	Standard deviation	**Interaction w/ full warranty**	Standard deviation	**Interaction w/ three installment**	Standard deviation
SHS price in 1000 Pakistani Rs	-3.230***	1.340***	-3.151***	1.244***	-3.167***	1.322***	-3.179***	1.277***
	(0.099)	(0.098)	(0.101)	(0.095)	(0.102)	(0.104)	(0.101)	(0.094)
HH head age interaction	0.130		-0.040		0.017		-0.073	
	(0.090)		(0.074)		(0.075)		(0.068)	
HH head education years interaction	-0.025		0.107		1.082***		0.135	
	(0.458)		(0.432)		(0.392)		(0.425)	
HH head literacy interaction	-2.668		-2.856		-7.408**		0.427	
	(3.908)		(3.694)		(3.014)		(3.250)	
No. of HH members interaction	0.493**		0.231		0.633***		-0.289	
	(0.231)		(0.208)		(0.217)		(0.189)	
Monthly HH expenses interaction	0.089*		0.107**		-0.001		-0.165***	
	(0.052)		(0.049)		(0.043)		(0.048)	
Health scale interaction	1.254		-0.315		-1.433		0.591	
	(1.045)		(0.949)		(1.005)		(0.924)	
Electricity attitude interaction	2.358*		3.172**		-1.256		-1.151	
	(1.347)		(1.299)		(1.857)		(1.492)	
Solar attitude interaction	2.378		1.422		2.215		-0.085	
	(1.587)		(2.024)		(2.213)		(2.038)	
NEP interaction	-6.806***		2.076*		3.208***		-0.777	
	(1.559)		(1.108)		(1.062)		(1.061)	
Life satisfaction interaction	-0.377		-0.580		0.618		-0.005	
	(1.186)		(0.983)		(0.986)		(0.932)	
IFC label	7.622	14.719***	17.495***	16.220***	17.777***	15.937***	17.888***	15.738***
	(6.369)	(1.573)	(1.686)	(1.540)	(1.620)	(1.529)	(1.779)	(1.693)
SVTC label	12.992***	10.617***	-0.032	-10.940***	12.087***	10.719***	12.443***	9.876***
	(1.221)	(1.249)	(5.665)	(1.310)	(1.254)	(1.361)	(1.295)	(1.348)
Six months warranty	17.657***		16.344***		16.303***		16.950***	
	(1.781)		(1.798)		(1.846)		(1.792)	
One year warranty	30.924***		28.791***		16.857***		29.166***	
	(2.731)		(2.784)		(6.103)		(2.756)	
Two installment payments	9.699***		9.199***		9.152***		9.346***	
	(1.068)		(1.052)		(1.008)		(1.096)	
Three installment payments	10.338***		10.228***		10.105***		22.548***	
	(0.881)		(0.947)		(0.914)		(5.312)	
n	19,470	19,470	19,470	19,470	19,470	19,470	19,470	19,470
Video treatment included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with socioeconomic indicator variables and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

The relationship between socioeconomic respondent characteristics and stated preferences for different SHS attributes is additionally investigated by estimating latent class logit models, which confirm the findings observed in Table 5.4. Table 5.5 shows estimation results based on latent class logit models specified with $Q = 2$ and $Q = 3$ respondent classes respectively. The first three columns of Table 5.5 show relevant coefficient estimates for the choices in both respondent classes (upper part of Table 5.5), as well as the socioeconomic characteristics predicting class membership for the first class over the second one. In the estimations based on $Q = 2$ classes, it can be observed that allocation to the second class was mainly dependent on a lower household literacy, a larger number of household members, higher monthly household expenses, and a higher stated appreciation of electric energy in general, and solar electricity specifically. Relative to the first respondent class, members of this class state higher preferences for both sustainability labels, as well as both warranty options (p-values < 0.01).

A similar picture can be observed when looking at the latent class logit estimation results with $Q = 3$ respondent classes (columns (4) – (8) of Table 5.5). Relative to the reference Class 3, average households in Class 2 can be described as more illiterate, larger with regards to household members, and with a more positive attitude towards (solar) electrification. They are also defined by slightly lower environmental preferences as indicated by the NEP score compared to the reference group. When looking at the stated preferences for SHS attributes of this group (column (5) of Table 5.5), it becomes clear that this group features the highest average preferences for SHS with the IFC and SVTC labels, as well as both warranty options (p-values < 0.01). Taking a specific look at the heterogeneity in respondent preferences for both sustainability labels, we observe a similar trend as in the mixed logit analysis (Table 5.4): Respondents in Class 1 show positive preferences for the IFC but not the SVTC label, while the opposite holds for respondents in Class 3. The class membership model outcomes given in column (7) of Table 5.5 show that one key difference between respondents in Classes 1 & 3 is their average score on the NEP scale. On average, respondents with higher stated sustainability preferences, as represented by the NEP score, preferred the SVTC label over the IFC label. The results in Table 5.5 also reiterate the fact that preferences for the installment options were mainly driven by financially constrained households, which are predominantly represented as members of Class 1. Appendix Table D.A5 shows the estimation results of similarly specified latent class logit models, excluding respondents that were confronted with the experimental videos.

Table 5.5 – Respondent Characteristics and SHS Preferences (Maximum Likelihood Estimation in a Latent Class Logit Model with Two and Three Respondent Classes)

VARIABLES	(1) Choice Class 1	(2) Choice Class 2	(3) Class 1 Member	(4) Choice Class 1	(5) Choice Class 2	(6) Choice Class 3	(7) Class 1 Member	(8) Class 2 Member
SHS price in 1000 Pakistani Rs	-0.027***	-0.075***		-0.227***	-0.062***	0.045***		
	(0.005)	(0.010)		(0.021)	(0.011)	(0.007)		
IFC label	0.028	2.282***		0.336***	2.349***	0.000		
	(0.050)	(0.156)		(0.116)	(0.152)	(0.064)		
SVTC label	0.091**	1.487***		-0.076	1.567***	0.204***		
	(0.046)	(0.119)		(0.133)	(0.115)	(0.068)		
Six months warranty	0.304***	1.925***		0.682***	2.011***	0.177**		
	(0.064)	(0.153)		(0.151)	(0.161)	(0.084)		
One year warranty	0.588***	2.994***		1.223***	3.097***	0.439***		
	(0.068)	(0.184)		(0.168)	(0.188)	(0.088)		
Two installment payments	0.468***	0.493***		0.990***	0.436***	0.275***		
	(0.057)	(0.099)		(0.150)	(0.101)	(0.076)		
Three installment payments	0.685***	0.334***		1.595***	0.321***	0.364***		
	(0.055)	(0.101)		(0.176)	(0.098)	(0.081)		
Class Share			0.575				0.242	0.401
HH head age			-0.008				-0.009	0.003
			(0.007)				(0.010)	(0.008)
HH head education years			-0.059				0.037	0.068
			(0.038)				(0.054)	(0.046)
HH head literacy			0.767**				-0.205	-0.784**
			(0.317)				(0.427)	(0.371)
No. of HH members			-0.077***				0.034	0.084***
			(0.021)				(0.034)	(0.025)
Monthly HH expenses			-0.010**				-0.034***	0.003
			(0.004)				(0.012)	(0.004)
Health scale			-0.103				0.106	0.123
			(0.093)				(0.120)	(0.104)
Electricity attitude			-0.466***				0.471***	0.573***
			(0.147)				(0.175)	(0.154)
Solar attitude			-0.552**				0.878***	0.871***
			(0.264)				(0.341)	(0.277)
Life satisfaction			0.025				-0.061	-0.005
			(0.098)				(0.129)	(0.114)
NEP			0.089				-0.674***	-0.305**
			(0.115)				(0.155)	(0.143)
Constant			3.248***				-1.041	-2.961***
			(0.650)				(0.826)	(0.701)
n	19,470	19,470	19,470	19,470	19,470	19,470	19,470	19,470
Video included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Expectation-Maximization Maximum-Likelihood estimation using the user-written Stata module *lclogit* (Pacifico & Yoo, 2013) with $Q = 2$ and $Q = 3$ respondent classes. Estimation results given in this table are based on a total of six choice sets per respondent. The upper part of the table reports fixed parameter estimates for the respective investor classes. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on z-statistics.

5.4.3. Previous Experience with SHS

Table 5.6 reports mixed logit model estimations in the WTP space on how average respondent preferences are potentially affected by prior exposure to SHS and/or heterogenous experiences with those systems. Based on the fact that the DCE was carried out as part of a quasi-experimental impact evaluation, which required us to stratify households based on whether or not they were previously provided with an SHS during the SCCDP, the first heterogeneity that is explored in this section is based on this very differentiation between households.[83] Accordingly, the first model reported in Table 5.5 includes interaction terms with a dummy variable indicating if a household was provided with an SHS during the SCCDP (i.e., being a solar household) or not. The estimation results suggest that beneficiary households stated significantly higher preferences for both sustainability labels (albeit only significant at the 10% and 5% significance levels respectively) and for both warranty options (p-values < 0.01). While at least the effect for the highest warranty is robust to both alternative sample and model specifications provided in Appendix Tables D.A7 and D.A8, this however does not hold for the other significant interaction effects observed in model (1) of Table 5.6. The fact that significance is lost especially in the preference space estimations with clustered standard errors suggests that the coefficient estimates reported in model (1) are biased upwards due to not accounting for the non-independence of observations within a village cluster. Still, these results suggest a first indication that the solar electrification measures within the SCCDP induced some degree of preference heterogeneity.

While the indicator variable for solar households does not take into account the current household solar electrification status, the estimation results provided in model (2) of Table 5.6 include interaction terms with an indicator dummy that takes on a positive value if a household stated to be using an SHS as their main source of electric energy during the time the DCE was conducted (n = 247 or 20.90% of households included in the final sample). The results in column (2) paint a clear picture: Households that are currently using an SHS as their main source of energy state significantly higher preferences for both sustainability labels, as well as both warranty options (all p-values < 0.01). In contrast to the effects reported in column (1), these are also robust to the alternative specifications shown in the Appendix section. It is noteworthy that the vast majority of households currently owning an SHS also belong to the subgroup of solar households (n = 196 or 79.34% of current solar owner households). Thus, while

[83] 49.66% of households were provided with an SHS during the SCCDP. Basic descriptive statistics on all four household experience indicator variables can be found in Appendix Table D.A6.

the average preference heterogeneity induced by being provided with an SHS during the SCCDP does not appear particularly pronounced, the results in column (2) suggest that there is significant heterogeneity related to whether solar households were able to maintain or replace the use of their system into the present day. Presumably due to the fact that the SHS that were disseminated during the project were advertised as high-quality products, these households developed a higher appreciation for high-quality indicators such as labels and/or product warranties. Irrespective of whether households understood the exact informational content of the labels regarding their sustainability benefits, the fact that positive user experiences with SHS have a positive effect on the (hypothetical) demand for such labels has important implications for the long-term sustainability of rural electrification initiatives.

This notion is further reinforced when taking the results of columns (3) and (4) of Table 5.6 into consideration. To further investigate the role of heterogenous solar user experiences within the SCCDP, here, the basis for the model estimations is only the subset of solar households. Respondents that no longer use the SCCDP-provided system as an electricity source due to previous technical malfunction (n = 292 or 49.74% of solar households) stated significantly lower average preferences for both sustainability labels and the warranty options. Especially the low average WTP for the IFC label and the highest warranty option among this respondent subgroup indicates a potential disconnect from trusting SHS quality indicators that could have negative repercussions on the sustainability of their future purchasing decisions. As these households are mainly driven by price considerations they might continue to opt for cheap and low-quality solar products that are already prevalent in the rural markets of the area. The results in column (4) further underline the trend suspected based on the results in model (2): The subgroup of solar households that stated a high degree of satisfaction with their solar system (n = 108 or 18.40% of solar households) show significantly higher preferences for the sustainability labels and both warranty options while stating a low average WTP for the two installment options.

Result 2.1.: Stated preferences for SHS attributes indicating a high product quality (sustainability labels and warranty) are on average affected positively by previous experiences with SHS.

Result 2.2.: Preferences for high-quality indicators are strongly affected by the quality of prior SHS experiences, where negative experiences dampen preferences for high-quality indicators, while a high degree of satisfaction with the systems has the opposite effect.

It is also noteworthy that the combination of the results reported in Table 5.6 addresses potential reservations against the experimental setup due to the influence of demand effects among certain respondent groups. Especially among solar households that were previously provided during the SCCDP but were not able to maintain their SHS in case of technical malfunction, one would assume respondents to follow what they believe the experimenter would regard as a “good” answer in order to qualify for them future disseminations, thereby increasing the hypothetical bias within this subsample. In the case of the study at hand, this is of special concern as the enumerators represented the same NGO (NRSP) that was responsible for the implementation of the SCCDP. Against this background, the assumption would be that this subgroup would state a specifically high preference for the sustainability labels in particular, as those were explained with a lot of detail and also the topic of two video treatments at least for a part of the sample. However, the results suggest the opposite, which is why I do not assume demand effects to play a significant role in the context of this study.

Table 5.6 – Heterogenous Experiences with SHS in WTP Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

	(1)		(2)		(3)		(4)	
VARIABLES	**Interaction w/ SCCDP**	Standard deviations	**Interaction w/ Current Solar**	Standard deviations	**Interaction w/ Solar malfunction**	Standard deviations	**Interactio n w/ Solar satisfied**	Standard deviations
SHS price in 1000 Pakistani Rs	-3.099***	1.241***	-3.134***	1.223***	-3.270***	1.268***	-3.396***	1.265***
	(0.087)	(0.085)	(0.091)	(0.084)	(0.132)	(0.123)	(0.162)	(0.111)
IFC Label interaction	3.522*		8.378***		-14.079***		25.551***	
	(1.909)		(2.756)		(3.373)		(7.643)	
SVTC label interaction	3.552**		8.785***		-10.252***		19.510***	
	(1.527)		(2.319)		(2.584)		(5.666)	
Six months warranty interaction	6.025***		10.063***		-9.526**		18.732**	
	(2.297)		(3.453)		(3.977)		(8.110)	
One year warranty interaction	7.104***		12.648***		-16.670***		22.911**	
	(2.494)		(4.029)		(4.558)		(9.874)	
Two installment payments interaction	-1.382		-2.276		2.889		-13.445***	
	(1.615)		(2.362)		(2.872)		(4.878)	
Three installment payments interaction	2.304		-1.190		4.607		-10.235**	
	(1.485)		(1.782)		(2.818)		(4.420)	
IFC label	15.075***	15.554***	15.725***	16.095***	28.408***	14.168***	19.371***	16.261***
	(1.495)	(1.329)	(1.494)	(1.362)	(3.714)	(2.253)	(3.164)	(2.942)
SVTC label	9.819***	10.132***	10.384***	-9.594***	20.032***	-9.762***	13.729***	9.205***
	(1.244)	(1.034)	(1.155)	(1.244)	(2.625)	(1.976)	(2.564)	(2.008)
Six months warranty	12.687***		14.272***		26.596***		21.364***	
	(1.561)		(1.535)		(3.894)		(3.876)	
One year warranty	23.689***		25.694***		43.037***		35.389***	
	(2.271)		(2.373)		(5.621)		(5.937)	
Two installment payments	10.157***		10.103***		8.020***		13.231***	
	(1.170)		(1.079)		(2.176)		(2.699)	
Three installment payments	9.743***		11.308***		11.450***		17.719***	
	(1.106)		(0.990)		(1.716)		(3.393)	
n	21,144	21,144	21,144	21,144	10,497	10,497	10,497	10,497
Video treatment included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with indicator variables for heterogenous experiences with solar electrification and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Standard errors are in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

5.4.4. Awareness Video and Video Treatments

Table D.A9 provides evidence concerning the effects of the video treatments by reporting estimation results from two models: The first model includes the full experimental sample and features interaction terms between a dummy indicator for seeing the video and the SHS attributes.[84] It can be observed that seeing one of the three different SHS awareness videos had a negative and significant effect on all reported SHS attribute preferences except the two installment options. However, none of the observed effects is robust to an alternative model specification in the preference space with village-clustered standard errors (see Appendix Table D.A10). The pronounced differences between both models based on the correction for village-level dependence between observations are intuitive, as the number of households sampled within a village that stated Urdu proficiency was very heterogenous across villages.[85] Following this line of argumentation leads me to prefer the model estimations in the preference space in this instance. Compared to the WTP space estimations given in Table D.A9, only the negative effect of the interaction between the video exposure and the medium warranty option remains significant (albeit only at the 10% significance level), while seeing the video appears to increase average preferences for three installment payments.

Again, focusing on the model outcomes in Table D.A10, the second model reports parameter estimates from a model including interaction terms between dummy indicators for both video treatments. As this model is only estimated on the basis of the subsample of respondents that did see a video at all, these coefficients for these interaction terms can be interpreted relative to the control video condition. While the video treatments addressing the merits of the two sustainability labels did not seem to have the expected positive effect on preferences for the respective labels (the results even suggest a negative effect of the IFC video treatment on IFC label preferences), the IFC video treatment apparently had a negative effect on warranty preferences indicating that the IFC label explanations convinced at least some respondents to substitute the relatively short one-year warranty for a label indicating product

[84] As indicated in Table 5.2 and explained in the corresponding subsection 5.2.4., only n = 389 or 32.91% of respondents were actually confronted with one of the three video versions.

[85] While only 13 out of 98 villages featured not a single household with Urdu proficiency, many villages featured only one proficient household, while in other villages almost all households fell into that category.

durability, while both label-related video treatments seem to have driven preferences for the installment options upwards, thereby reinforcing the finding from model (1) in Table D.A10.

Result 3: Preferences for sustainability labels are not positively affected by prior exposure to awareness videos addressing the features of said labels.

Aside from the video treatment potentially just being too weak of an intervention to bring forward the expected effects, further explanations for these findings could also rest within systematic socioeconomic and/or attitudinal differences between households with or without Urdu proficiency, which determined whether respondents watched a video prior to the DCE or not. Appendix Table D.A11 lists summary statistics and mean differences between these two respondent subsamples for the established set of socioeconomic variables. A straightforward explanation for the relatively high installment preferences among respondents with Urdu proficiency could be that they are more likely to be from lower-income households.[86] This notion is indeed confirmed by the results displayed in Table D.A11, however not to a statistically significant degree. However, households with Urdu proficiency are significantly younger, more educated and literate, state a higher self-perceived health and life satisfaction, while also stating a more positive attitude towards electricity and SHS. While the positive relationship between Urdu proficiency and educational outcomes is straightforward, it could also be argued that higher levels of education are positively linked with a better understanding of the merits of electric energy. A potential explanation based on this notion could be that the subsample of households with Urdu proficiency somehow regarded the videos as more of a general advertisement of SHS and that the higher average WTP for the installment options reflects an increased genuine interest in purchasing an SHS in response to the video. A related explanation could be rooted in that Urdu-proficient households overrepresent grid electrification status when compared to the rest of the sample.[87] Overall, respondents who indicated the national electricity grid as their main source of electricity were, mostly due to reliability issues, relatively more likely to be unsatisfied with the connection (43.23% among all grid-connected households and 40.85% in the Urdu-proficient subsample) when compared to, e.g., respondents with an SHS as their main source (15.30% among all households with an SHS). To fill electricity provision gaps due to blackouts, etc., Urdu-proficient households might be more likely to have a genuine and immediate interest in acquiring an SHS when compared to the rest of the sample, explaining the high average preferences for installment options within this subsample.

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[86] The results highlighted in subsection 5.4.2. indicated that financially constraint households were more likely to state high preferences for the installment options.

[87] While at the time of the DCE, 32.49% of households stated their main electricity source to be a grid connection, this share increases to 42.16% when only looking at the subsample of Urdu-proficient households. This is likely related to the more favorable geographic location of these households: On average, households with Urdu proficiency are situated in villages that are 0.51 km closer to the closest asphalt road, however, this difference is not statistically significant (p-value = 0.11). This geographic heterogeneity is also a likely explanation for the differences in educational outcomes between Urdu-proficient households and the rest of the experimental sample.

5.5. Conclusion

Solar electrification is widely expected to play an important role in bridging the gap toward universal electrification. In the context of rural electrification initiatives, solar systems are especially appealing for their relatively low production and dissemination costs, as well as their favorable ecological footprint when compared to the extension of grid lines, which still rely mostly on fossil-based energy sources (Adenle, 2020). While the body of literature on the socioeconomic impact of rural electrification projects using small-scale solar electricity systems has been steadily growing in recent years (Aklin et al., 2017; Furukawa, 2014; Grimm et al., 2017), an understudied aspect of such projects are their long-term implications with regards to ecological sustainability. If the dissemination of solar energy to formerly unelectrified areas is supposed to act as a long-term driver of sustainable development (United Nations, 2011), fueling the creation of self-sustaining markets for solar products after the initial dissemination phase should be taken into consideration as well (Wakkee et al., 2014). However, the development of such markets crucially depends on the experiences of first-time solar energy users with the new technology. While positive user experiences are likely to translate into positive preferences for quality solar products, which in turn affect future purchasing decisions and thereby contribute to the long-term sustainability of solar electrification projects, negative experiences could have the exact opposite effect: When the first experience with solar products is tainted, e.g., through technical issues, costly maintenance or disappointment regarding the capabilities of small-scale systems, energy consumers could become disengaged from the novel technology and either return to using no electric energy at all (negatively affecting social sustainability) or even switching to fossil-based energy when given the opportunity (negatively affecting ecological sustainability).

To shed light on the long-term sustainability implications or rural electrification projects relying on solar energy, a DCE on the hypothetical purchase of solar products characterized by different attributes relating to the product's sustainability (as signaled by two labels implying favorable product performance with regards to two distinct sustainability dimensions), warranty and mode of payment was conducted in southern Sindh, Pakistan. The DCE was carried out in the context of a large-scale household survey (n = 1,182) in a rural area that was subject to a solar electrification initiative on the household level a decade prior. While the overall outcomes of the DCE allow me to investigate if rural households in an area characterized by low rates of electrification, income, and education would even consider paying a price premium for sustainability indicators on solar products, the additional information collected during the household surveys allows for an investigation on which socioeconomic indicators characterize these households. Additionally, the sampling of households from villages with varying previous experiences with solar electricity allows for a detailed investigation on how this heterogeneity affects respondent preferences for different SHS attributes, especially for those indicating an increased degree of product sustainability. To investigate how stated sustainability preferences might be affected by informational material, experimental variation was introduced in the form of awareness video treatments, informing respondents in the control condition about the general merits of solar energy over alternative energy and lighting sources, while respondents in the treatment conditions were subjected to one of two additional video sections containing specific explanations on the two sustainability labels.

Estimation results from mixed logit regressions indicate positive and significant average preferences for both sustainability labels among the study population. Unsurprisingly, between both labels, the average respondent stated higher preferences for the IFC label, which indicated a high product safety and longevity, as compared to the SVTC label, which was supposed to signal a solar panel production with a low ecological footprint to the respondent. Against this generally positive sustainability outlook, however, the average respondent still stated the highest WTP for a classical product warranty, even if this would only cover product malfunction for one year. Following expectations, stated sustainability preferences, as measured by selected items from them NEP scale (Dunlap & Van Liere, 1978), explain a lot of preference heterogeneity between both sustainability labels, where respondents with a higher NEP score show a higher average WTP for the SVTC label. While the option of paying in installments payments was generally the least preferred attribute within the hypothetical purchasing situation, WTP for this attribute increased among more financially constrained households. Furthermore, the results suggest interesting heterogeneity in SHS preferences in response to prior experiences with solar technology: While previous exposure to a rural solar electrification project has a positive average effect on stated preferences for attributes indicating a high product quality (both sustainability labels, as well as product warranty), a more in-depth investigation of the subsample of beneficiary households within the investigated electrification project shows that these preferences are highly heterogenous depending on the quality of the experiences. Compared to the rest of this subsample, households that were unable to maintain their solar electricity connection due to SHS malfunction stated significantly lower preferences for high-quality indicators, while the opposite effect can be observed for households stating a high degree of satisfaction with the SHS. Finally, the video treatments did not seem to have a conclusive effect on the sustainability labels, while explaining increased average preferences for the installment options. However, this finding can likely be attributed to the specific socioeconomic characteristics of the subsample of respondents that saw the video.

With regards to the long-term sustainability implications of rural solar electrification projects, the study results provide a mixed picture: While on average, rural households appear to have a positive appreciation of sustainability labels, suggesting positive potential for educating people in rural areas of low-income countries about the merits of solar technology, respondents still are more strongly drawn towards short-term and unspecified warranty options and do not seem to take into account the advantages of product certifications, even if these are intuitively communicated through awareness videos. The results suggest that preferences for both label options are strongly dampened by negative previous experiences with solar technology, in our case reflected by not being able to use a previously received SHS anymore due to technical malfunction. While this could be regarded as negligible in case studies where this is only a rare occasion, the electrification project providing the context for the study at hand serves as an additional warning example to what has already been reported in related literature (Groenewoudt et al., 2020): About half of the sample lost electricity access in this manner over a timespan of only about ten years. If, as suggested by the results, this drives households to consider cheaply produced and unreliable products with a bad ecological footprint for their next purchase or makes them even switch to fossil-based energy sources entirely, the long-term sustainability implications could be disastrous. On a more positive note, this finding is contrasted by households with a high degree of satisfaction with their SHS stating a high demand for both types of sustainability labels. In conclusion, the study results provide quantitative evidence that rural electrification projects going forward need to ensure that an adequate system of long-term follow-up monitoring, especially including technical maintenance and support is accounted for, thereby supporting the notion brought forward in related literature (Chowdhury & Mourshed, 2016; López-Vargas et al., 2021). If real and long-term sustainable development is supposed to be achieved, rural electrification initiatives cannot afford to lose new adopters of solar energy, especially not at such early stages.

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Chapter 6 - Conservation Preferences as Policy Impacts

by

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Abstract: Academic research concerned with the impacts of conservation policies acknowledges that the behavior of local natural resource users is not only affected by economic incentives but by a diverse set of motivations and underlying values. Especially in cases where policies are struggling to fulfill financial promises to local communities, these non-monetary drivers are crucial in safeguarding long-term positive conservation outcomes. However, measuring and disentangling these factors still constitutes a significant challenge. We present a conceptual and methodological contribution rooted in economics to approach this issue. First off, the concept of 'conservation preferences' is introduced, encapsulating the individual motivations and tradeoffs inherent to conservation decisions. Building on lessons learned from established methodology such as attitudinal or behavioral measures, we then introduce a novel and convenient approach to measure conservation preferences based on contingent valuation methods and experimental donation tasks. We exemplify this approach within the context of a case study in northern Namibia, where it was employed to investigate whether exposure to a community-based conservation program has an effect on individual conservation preferences. Our findings highlight that our approach can be a suitable complement or substitute to established measures for conservation preferences, while avoiding some of the existing pitfalls such as demand effects or costly data collection associated with behavioral and attitudinal measures.

Keywords: Conservation preferences, Conservation policy, Community-based natural resource management, Donations, Contingent valuation, Deliberative monetary valuation, Hypothetical bias, Namibia

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6.1. Introduction

Academic research on conservation policies and environmental management practices for long has acknowledged that environmental stewards and natural resource users are not solely driven by economic incentives but that their behavior is guided by a diverse set of motives and underlying values (Satterfield, 2001). While inclinations for conservation action have a history of being measured via agreement to attitudinal or value-based statements (Nilsson et al., 2020), approaches of this kind have recently come under scrutiny, amongst others due to increasing concerns about phenomena such as the value-action gap (Kollmuss and Agyeman, 2002). Behavioral measures with a direct link to actual conservation behavior have been suggested as an alternative to attitudinal statements (Nilsson et al., 2020). The empirical contributions around 'motivation crowding' by economic incentives in the conservation context rely to a large extent on behavior-based measures to approximate the motivation for conservation (Rode et al., 2015). There are clear indications that depending on context conditions and design specifics, policies that provide economic incentives can increase ('crowd in') or decrease ('crowd out') other non-economic motivations for conservation (Hayes et al., 2022; Moros et al., 2019).

And yet, it remains a major challenge to disentangle whether the underlying motivations driving conservation behavior are merely of financial nature or if they are reflecting a genuine interest (or 'intrinsic motivation') in conservation itself (Rode, 2022). Policy evaluation should ideally be able to clearly separate these two dimensions. Particularly in cases where economic benefits to local communities are only temporary (e.g., via donor support in implementation stages), or fail to materialize at all, an increase of intrinsic motivation induced by these policies is thus crucial to achieve longer term positive conservation outcomes (Hayes et al., 2022). In this article, we build on terminology and empirical traditions from economics and refer to the concept of 'conservation preferences' to investigate the motivations for conservation behavior and the impacts of conservation policies. We showcase an application of preference measurement that allows circumventing some of the challenges associated with more traditional attitudinal or behavioral measures of pro-environmental motivations.

What are conservation preferences? Economists conceptualize preferences as the drivers of individual decision-making and behavior (Falk et al., 2018; Hausman, 2011). If a person has positive conservation preferences, this person can thus be expected to be supportive of conservation interventions and also to individually act in favor of conservation outcomes (Selinske et al., 2020). E.g., in a choice situation characterized by individual trade-offs, a person with stronger conservation preferences would be willing to accept more economic losses in order to ensure a positive conservation outcome than a person with lower conservation preferences. Thereby, conservation preferences share conceptual similarities to key concepts from psychology such as 'motivations' (Ryan and Deci, 2000), values (Shiell et al., 1997), and 'attitudes' (Nilsson et al., 2020) for conservation. In this paper, we cannot fully alleviate the complexity of delineating these different concepts. Instead, we intend to clarify in particular the role of economic methods among the plurality of related tools from different disciplines to measure conservation preferences.

Are conservation preferences important to consider when implementing, managing, and evaluating conservation policies? Conservation practitioners would likely agree that the level of support for conservation action and the likelihood to act in line with conservation goals are desirable outcomes of many policy interventions. And yet, conservation preferences have to our knowledge not yet been treated explicitly as policy impacts. One reason for this could be that neoclassical economics traditionally conceptualized individual preferences to be stable over time, similar to how personality traits are viewed in psychology. By definition, this would not make them the subject of policy evaluations. Individual attitudes, on the other hand, are considered to be less stable (Achen, 1975) and to be changing with experience or depending on the specific context (Gifford et al., 2011). The assumption of stable preferences has always been contested within the social sciences and preference instability has been captured within concepts such as 'endogenous' (Bowles, 1998) or 'adaptive' preferences (von Weizsäcker, 2005). Once preferences are no longer regarded as a stable character trait, they can indeed be considered as outcome variables of an (environmental) policy process. In the context of conservation preferences, this allows drawing on the methodological merits of preference measurement, which we highlight in more detail in Section 6.2. Many economists have been wary of mere statements of preferences, which they consider "cheap talk" (Farrell and Rabin, 1996), and have favored 'revealed preferences' measures based on real-world observations of actual behavior (Frey and Stutzer, 1999). Nevertheless, another line of economics research, especially related to the valuation of environmental goods, relies on so-called contingent valuation methods, where individuals' hypothetical "willingness-to-pay" statements indicate their 'stated preferences' (Carson, 2012; Hausman, 2012). This article highlights how the different economic methods to measure conservation preferences can add valuable insights into whether and how a certain policy has influenced the way people relate to conservation. In particular, economic measures of conservation preferences may provide more conservative estimates than attitudes or related psychological concepts.

Particularly interesting applications of conservation preferences as policy impacts are found within the context of community-based conservation programs such as Community-based Natural Resource Management (CBNRM) or Payments for Ecosystem Services (PES). These approaches are frequently presented as win-win solutions, in which both biodiversity conservation and economic well-being can be promoted simultaneously. However, scenarios which effectively overcome the complex tradeoffs between those two objectives may be relatively rare and difficult to realize in the first place (Hegwood et al., 2022; McShane et al., 2011; Muradian et al., 2013). When policies like CBNRM or PES attempt to reconcile conservation and human well-being by providing economic incentives, it is often assumed that conservation preferences are positively affected. The following stylized example shows that this may not always be the case. Table 6.1 illustrates and describes four stylized outcomes of conservation behavior from conservation initiatives or policies, depending both on the realization of economic benefits for the local population and their influence on conservation preferences. Cell C represents the case in which CBNRM programs include a bundle of interventions such as awareness raising and information campaigns that strengthen conservation preferences irrespective of any economic benefits (Green et al., 2019). Cells A and B represent incentive-based policies that provide economic benefits to the community. The effect of such policies on conservation preferences can go both ways depending on their design and the socio-cultural context – incentives have been shown to potentially enhance (crowd-in) or decrease (crowd-out) non-economic motivations for conservation (Ezzine-de-Blas et al., 2019; Rode et al., 2015).

Table 6.1 - Dependency of Conservation Behavior on Conservation-related Preferences and Economic Benefits

Net effect on conservation behavior		**Increase in conservation preferences of resource users**	
		Yes	**No / Unclear**
Economic net benefits to resource users	**Yes**	A (++)	B (+, o, or -)
	No	C (+)	D (o or -)

Note: In the presence of economic net benefits (cases A and B), positive conservation actions do not depend on the presence of conservation preferences. However, one would expect communities with strengthened conservation preferences (case A) to be more receptive toward additional conservation actions that do not generate economic returns per se. A decrease in conservation preferences may even result in a net negative effect on conservation behavior (case B). When conservation initiatives lack economic benefits (cases C and D), then positive conservation actions are conditional on enhanced conservation preferences (case C). Finally, one would not expect positive conservation behavior, if no financial benefits are generated nor conservation preferences are enhanced (case D).

In Section 6.2 of this paper, we first describe different proxy measures of conservation preferences and assess their advantages and disadvantages. In particular, we contrast attitudinal measures and statement-based measures on conservation behavior with economic measures, notably hypothetical willingness-to-pay (WTP) statements and real donation tasks. In addition to their appeal of relatively low implementation costs and the comparability of multiple measures on a common scale, the economic proxies seem attractive due to their highly flexible design properties. The scenario underlying both the hypothetical WTP statements and the real donation tasks can be adjusted in such a manner that it reflects different conservation issues suitable to the context at hand. Moreover, it can be designed in such a way that researchers are able to clearly distinguish “pure” conservation preferences from preferences for direct monetary or non-monetary economic benefits from conservation actions. The methods can be adapted to investigate how other potential design considerations of conservation policies (e.g., individual or group deliberation, framing of conservation benefits, etc.) can affect conservation preferences.

In sections 6.3 (study design) and 4 (results) we conceptualize and measure conservation preferences within a case study on community conservancies in Namibia, one of the most prominent and long-standing CBNRM programs in Sub-Saharan Africa (Boudreaux and Nelson, 2011). This program represents a scenario in which the aforementioned economic incentives have widely not materialized, thereby increasing the importance of considering conservation preferences (case C or D). The case study further enables us to scrutinize two methodological key issues related to economic measures of conservation preferences: First, observing both hypothetical WTP statements and real donations on an individual level allows us to evaluate potential differences in the hypothetical bias between study sites. Differences in hypothetical bias between study sites could arise from potential demand effects, either within CBNRM conservancies where community members might want to paint a positive picture in order to acquire additional external support or funding, or outside conservancies, where individuals might be tempted to pretend positive conservation attitudes in order to be considered for conservation projects in the future. If we are able to detect systematic differences in the hypothetical bias between study sites, it could be argued that the hypothetical WTP statements cannot provide reliable approximations of conservation preferences on their own. Second, we use our case study to experimentally investigate the effect of group deliberation on the measures of conservation preferences. For this, we randomly assigned half of our sampled respondents to a treatment in which they can discuss their statements with a randomly selected group of fellow community members. Following the argument brought forward in (Spash, 2007), stated preference techniques are under scrutiny for assuming well-informed preferences among respondents, and deliberative monetary valuation (DMV) is presented as a potential remedy to this issue. In the context of our case study, the average effect of group deliberation on the conservation preference measures may differ between study sites. After years of being directly exposed to pro-conservation education and incentivization, people living in conservancies might have more well-defined conservation preferences when compared to people living outside conservancies. In this case, the difference in outcomes between individual and group deliberation would be smaller in conservations than outside of conservancies. The conservation cause to which respondents could contribute monetarily (protection of an endangered bird species) was chosen and designed to ensure a representation of conservation preferences avoiding conflation with economic benefits from conservation.

The results of our case study highlight the prospective benefits of hypothetical WTP statements and real donation tasks to elicit conservation preferences: While we find evidence for lower conservation preferences within conservancies compared to outside villages, we more importantly conclude that the results are not driven by hypothetical bias or the particular elicitation method (group vs. individual deliberation), underlining the validity of our methodological approach.

6.2. Measuring Conservation Preferences

Intuitively one may presume that the evolution of conservation preferences over time would ideally be monitored by observing real-world conservation behavior and assessing the direct links to conservation outcomes, such as a reduction of deforestation or poaching figures within a randomized experimental context. Monitoring such outcomes, however, is in many cases practically infeasible, or difficult and costly to implement (Nilsson et al., 2020). Crucially, approaches of this kind would also not be able to differentiate between conservation motivations relating to the altered economic cost/benefit ratio of conservation activities within respective programs and the more genuine interest in conservation which we refer to as conservation preferences. The following paragraphs explain alternative approaches for measuring conservation preferences.

6.2.1. Attitudinal Measures

Psychologists traditionally investigate how values, attitudes, and norms change, which are assumed to influence behavioral intentions and actual behavior (de Groot and Steg, 2008; Fishbein and Ajzen, 1975; Stern and Dietz, 1994). In particular, attitudinal measures are a common tool in psychological research on biology conservation and are used to evaluate the effectiveness of conservation programs (Nilsson et al., 2020). Attitudinal statements rely on Likert-scale ratings, using items such as the New Ecological Paradigm (NEP) scale (Dunlap et al., 2000) or via items directly relevant to the specific conservation case, as e.g., individual attitudes on (un)desired conservation behavior, endangered species or wildlife management practices (Nilsson et al., 2020).

From a policy perspective, an increase in pro-conservation attitudes may be regarded as a success per se or may be expected to lead to favorable behaviors. The main virtue of eliciting attitudes to evaluate conservation preferences is that it is quick, cheap, easily implementable, and, depending on the use of standardized scales, also comparable across different study contexts. Widely applied scales, such as e.g., the NEP, have been typically tested for reliability and validity, however often only in specific cultural (i.e., western) contexts. While attitudes have been shown to predict pro-environmental behavior, on average they only do so imperfectly (Armitage and Conner, 2001); the phenomenon commonly referred to as "attitude-behavior-gap" in environmental economics and psychological literature (Farjam et al., 2019). Experimental economists have also pointed out that attitudinal scales are also especially prone to demand effects (Zizzo, 2010). In this case, respondents would consciously or unconsciously provide answers in line with their belief of the researcher's expectations. For example, respondents may provide systemically biased answers if they expect that these answers increase the chances of attracting or retaining conservation projects and associated funding. This is especially problematic when using attitudes as a measure to compare conservation preferences between sites that have had different levels of exposure to conservation programs as e.g., CBNRM.

6.2.2. Behavioral Intentions

As a way to get closer to conservation behavior, many studies have used self-reported behavior (e.g., "Do you typically engage in wildfire control measures?") or behavioral intentions (e.g., "In the coming month, do you plan to engage more regularly in wildfire control measures?") to approximate people's conservation preferences. While survey items of this type can be regarded as advantageous over scale-based attitudinal statements as they can be adjusted to the specific context in the conservation intervention in question, as hypothetical statements, they suffer from similar drawbacks as the attitudinal measures, namely being prone to demand effects and an unclear correspondence to real behavior (Webb and Sheeran, 2006). These issues may be particularly pronounced when the behavioral intentions relate to potentially incriminating practices as e.g., poaching or illegal logging. Additionally, in contrast to purely attitudinal statements, behavioral intentions can be already influenced by economic constraints, i.e., material pay-offs associated with specific behavior. Conservation programs may alter these parameters and thus affect behavioral intentions without changing underlying conservation preferences.

6.2.3. Stated Preferences: Willingness-to-pay (WTP)

Economists have a long tradition of measuring preferences on the basis of monetary values, either by observing actual behavior (e.g., purchases on markets) or by eliciting stated preferences of willingness-to-pay (WTP). Stated WTP are typically elicited using the 'contingent valuation' approach (Carson, 2012; Hausman, 2012; Kling et al., 2012) where study participants are asked to state their hypothetical WTP for e.g., an environmental good. While in the most typical case, this approach is used to derive an economic value of environmental goods (e.g. Carson et al., 2003) to inform environmental policy, individual WTP can also be regarded as a proxy for individuals' conservation preferences. In the latter case, the valuation scenario should be carefully designed. For example, the WTP question could be framed as a one-off payment to promote the conservation of a nature reserve or an endangered species. Importantly, all respondents (both targeted and not targeted by the policy or intervention at hand) should face similar economic (dis)incentives towards the respective conservation good. Rather than focusing on the absolute monetary levels WTP - in this application - is a relative, comparative measure for conservation preferences between populations (e.g., targeted and not targeted by a conservation project) or over time.

The fact that such WTP statements are purely hypothetical renders them conceptually similar to the previously discussed behavioral intentions – a person states the intention to act in a certain way (making a payment in this case) – and they therefore are prone to similar problems. The contingent valuation method is under constant criticism for its susceptibility to a phenomenon frequently referred to as 'hypothetical bias', i.e., that studies applying such methods would systematically lead to the overestimation of environmental values (Hausman, 2012). Others argue that people do not have well-defined preferences for goods that are not commonly exchanged in market settings (Hsee and Rottenstreich, 2004; Spash, 2007) and that some respondents may even protest against monetary attribution of nature (Spash et al., 2009). Financial constraints may also render money a questionable unit for conservation preferences, e.g., when poor communities do not have the ability to support conservation activities financially (Martínez-Alier, 2002). However, in contrast to typically highly context-specific measures of behavioral intentions, WTP statements allow for a context-free and relative comparison of conservation preferences between different study sites, while clearly reflecting the trade-offs between financial and conservation outcomes inherent to conservation. The ease of comparability in combination with the high degree of flexibility in designing WTP scenarios enables researchers to easily enhance this approach with additional experimental interventions which can yield new insights into how and what might drive changes in conservation preferences. Examples for such interventions could be information or framing treatments relating to the conservation cause in question, or, as also brought forward in the case study presented in this paper, the implementation of group deliberation sessions. Still, stark income differences between study sites may render comparisons of hypothetical WTP measures in absolute terms difficult.

6.2.4. Behavioral Measures (Revealed Preferences)

While preference measures based on observed behavior provide more objective and reliable behavioral data than the aforementioned approaches based on self-reported statements and intentions, they come with the obvious downside of being relatively costly to implement, especially when conservation behavior is supposed to be monitored over a longer period of time (Floress et al., 2018). Moreover, as discussed above, conservation projects commonly aim to alter the costs and benefits associated with conservation actions. Differences in conservation behavior between intervention and control populations are likely to reflect changes in monetary (dis)incentives rather than a fundamental shift in the underlying conservation preferences. In other cases, conservation interventions may have already proved successful in improving environmental quality to an extent that additional behavioral adjustments can hardly be expected, even though the intervention might have in principle strengthened conservation preferences. Thus, we postulate that it could be more desirable to create a situation that enables the measurement of revealed preferences ceteris paribus, i.e., independent of actual incentives or past conservation efforts.

6.2.5. Donations

Real monetary donations towards a conservation cause conceptually represent a specific behavioral measure. Such measures are typically assumed to measure altruism coming at a real personal cost and they have been used in multiple studies from the field of experimental economics to approximate altruistic preferences towards social or environmental causes (e.g., Blanco et al., 2012; Champ et al., 1997; Rode et al., 2008). The cause for which people are asked to donate can be selected in a targeted way such that donations capture underlying conservation preferences as opposed to economic dis(incentives) from conservation. As for WTP measures above, financial constraints may however render money a questionable measure for conservation preferences, e.g., when poor communities do not have the ability to support conservation activities financially (Martínez-Alier, 2002). Recent, studies have employed donation tasks in combination with contingent valuation scenarios in experiments to investigate how WTP bids to support public causes are driven by behavioral factors (Bouma and Koetse, 2019). In the remainder of this article, we aim to showcase how a combination of both WTP measures and donations can be applied to measure and investigate underlying conservation preferences based on a case study on CBNRM in Namibia.

Table 6.2 - Methods for Eliciting Conservation Preferences

Method	Attitudes	Stated Preferences		Revealed Preferences	
		Self-reported behavior and behavioral intentions	WTP	Observed Behavior	Donations
Advantages	- Fast and easy to collect - Potentially applicable in different contexts (e.g., New Environmental Paradigm Scale, but not always given) - Previously tested (reliability/validity)	- Change in human behavior is often the targeted outcome of interventions -Relatively easy and fast to collect	- No financial constraints since WTP is hypothetical - Highly flexible and adjustable to specific conservation contexts	- 'First best' solution to measure actual behavioral changes	- Decisions have direct, financial consequences (trade-off) - Donation can be chosen to explicitly rule out any direct, economic benefits
Disadvantages	- Demand effects - Link to actual conservation behavior not always given	- Interventions may change (dis)incentives to engage in a specific behavior (monetary payoffs, social norms, level of env. quality) - Recall bias for self-reported behavior - Demand effects - Difficult to disentangle motivational drivers (conservation preferences and economic benefits)	- Hypothetical Bias - Demand effects - Hypothetical valuation might be unfamiliar (could be reduced with group deliberation and sufficient time)	- Difficult to disentangle motivational drivers (conservation preferences and economic benefits) - Difficult & costly to monitor - Lack of experimental control	- Limited resources reduce the scope to donate even though conservation preferences exist - Costly implementation

6.3. Case Study

6.3.1. Context and Sampling: CBNRM in Namibia

CBNRM in Namibia is often considered a success story of nature conservation in Africa (a detailed description of CBNRM in Namibia and our selected conservancies can be found in Appendix Section E.A). Conservancies within Namibia's national CBNRM program cover a total area of 166,045 km^2, amounting to 52.9% of all communal land in Namibia. However, although some conservancies have successfully developed income sources from tourism or hunting, substantial economic benefits have not materialized for the majority of conservancies. As of 2017, 15 (18%) officially registered conservancies generate no cash income at all, and 45 (54%) are unable to fully cover their operating costs (NACSO, 2018, pp. 56, 65). The financial incentives in conservancies may further decrease if donor and NGO support will reduce over time (Boudreaux and Nelson, 2011). Also, rising wildlife numbers are expected to go hand-in-hand with an increase in human-wildlife conflicts (NACSO, 2018, p. 45).

Our research was concentrated on two conservancies located in northeastern Namibia: The Joseph Mbambangandu Conservancy (JMC), established in 2004, and the George Mukoya Conservancy (GMC), established in 2005. The selected conservancies are not atypical. Based on the available data, the GMC and especially the JMC belong to the lower-achieving categories of conservancies in terms of financial revenues (see Appendix Section E.A.B). We consider both conservancies prime examples for showcasing the importance of conservation preferences as positive conservation outcomes will likely rely on these underlying drivers due to the absence of tangible financial incentives (corresponding to case C or D in Table 6.1).

Sampling was conducted in two stages. First, we sampled all four settlements located in the JMC, along with two of the eight villages located in the more remote, barely accessible, and less densely populated GMC[88] In order to identify "control villages" outside of the conservancies, 58 villages in relative proximity to the main road and the two conservancies were identified using official records. Five localities situated close to the JMC and two localities situated near the GMC were then randomly selected for the final sample. Twelve participants per village were randomly recruited during village meetings, which were organized by the respective local headman, resulting in a total sample size of 156 observations. In adherence to local ethical research standards, the field team visited all villages a few days before the actual survey work in order to acquire approval from the respective village headman, thereby providing them with time to inform all village members about the opportunity to participate and the random nature of the sampling process. All respondents provided informed consent before entering the survey sessions, and they were filled in on data confidentiality and anonymization. Each respondent was remunerated with a fixed participation fee of 30 NAD, which roughly translated to the daily wage

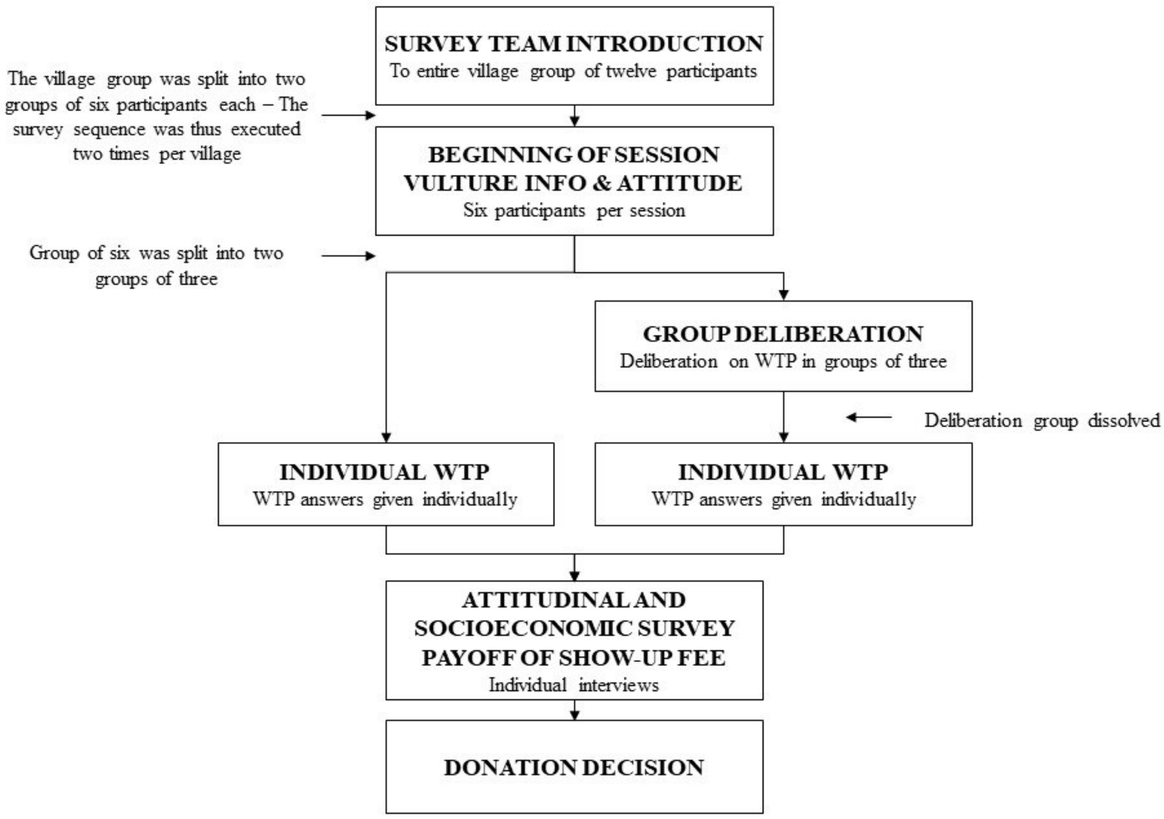
[88] Of the eight villages in the GMC, two were not accessible by the research team. The two sampled villages were randomly selected from the remaining six villages.

for regional farm workers at the time of the study. All interviews took place in September 2017. The socio-economic characteristics of participants by conservancy status are provided in Appendix Table E.C5.

6.3.2. Study Design

As previously indicated, we designed the survey instrument with the main purpose of eliciting two different measures for conservation preferences. In particular, we elicited a) the WTP through a hypothetical donation scenario, and b) real donations by including an opportunity to donate at the end of the survey. The additional inclusion of two different deliberation methods (individual vs group-based) as experimental treatments allows us to assess whether potential differences in conservation preferences between conservancy and non-conservancy villages are sensitive to this design dimension. The sequence of our multi-method survey approach is illustrated in Figure 6.1. The measures for conservation preferences are described below; a more comprehensive description can be found in Appendix Section E.B.

Figure 6.1 - Illustration of Study Sequence



First, we employed a contingent valuation scenario for a one-time donation to a Namibian conservation project, concerned with monitoring and saving the remaining populations of the lappet-faced vulture (*Torgos Tracheliotos*), an endangered bird species native to almost all of Namibia. Exploiting the flexibility of the contingent valuation method, and directly relating to our argument regarding behavioral changes driven by altered cost/benefit ratios due to conservation interventions, we chose to focus our scenario on a species that is not directly related to the income of village inhabitants in this area by any means (as opposed to e.g., a scenario featuring any of the "Big Five" animals attractive for eco-tourism or other aspects related to residents' livelihoods, such as wildfire protection). We thereby eliminate potential issues relating to WTP statements being affected by economic self-interest outside of personal budget constraints. The elicited WTP statements (and donations) should be associated mainly with the non-use values (in particular, existence values) of the lappet-faced vultures.

After respondents were provided with basic information on the lappet-faced vulture, they were asked to answer a set of Likert-scale questions regarding their attitude toward the animal, as well as their personal experience with it. Although no one reported ever seeing a lappet-faced vulture, all respondents indicated that they had seen other kinds of vultures. Thus, in line with our reasoning above, respondents could be expected to value the vultures only for their existence and ecosystem service provision as a contributor to natural pest control (Ogada et al., 2012). We then presented detailed information on the vulture conservation project and subsequently asked for the WTP amount that respondents hypothetically would be willing to donate to the conservation project. To facilitate the respondents' decisions, this was done with the help of so-called payment cards.[89]

Hypothetical donations are a common mechanism in contingent valuation scenarios (e.g., Baral et al., 2007; Bateman et al., 2002). One common alternative mechanism is tax increases. Respondents would be asked what tax increase they would be willing to support for the specific cause. In our specific case, tax increases as a payment vehicle would likely be considered implausible, since most if not all respondents in our sample do not pay any income or wealth taxes. Second, one-time donations allowed us to directly compare the magnitude of the WTP with the donations we elicited at the end of the survey. Naturally, a one-time donation is easier to implement in an area where people have barely any means to make recurring payments, e.g., via mobile-payment applications, etc.

The WTP measure and the actual donations could be compromised if respondents within and outside of conservancies believed that they already contributed through other means to the conservation of the specific species. Given the low awareness and knowledge about the lappet-faced vulture among respondents, it is unlikely that people living in the surveyed conservancies might feel that they already

[89] Payment cards elicit individual WTP responses with the help of a range of values presented to the respondents in the form of a list. Following recommendations from established literature on this topic (Bateman et al., 2002), this elicitation format was chosen over other alternatives because it provides a credible context for the possible donation amounts, avoids starting point bias and reduces unrealistic outlier responses. After pretesting, we decided to present respondents with values ranging from 0 NAD to 40 NAD.

contribute to vulture conservation by means other than donating to the project. Neither of the conservancies has explicitly implemented measures to protect vulture populations or any other endangered species. Targeting a species that is more common and directly associated with CBNRM would have been riskier, as conservancy members may already incorporate their individual contribution to the protection of the species into their WTP bids and/or donations.

We tested for the effect of group deliberation on our different measures of conservation preferences by allocating half of the respondents to small groups of three (see Figure 6.1) in which they were asked to jointly discuss their hypothetical donation to the vulture conservation project. Participants were allowed to deliberate for a minimum of three to five minutes. After the deliberation, each respondent reported their individual WTP privately. Stated preference studies increasingly apply group settings in which respondents are given the opportunity to discuss the costs and benefits associated with the good for which WTP is elicited (Kenter, 2016; Spash, 2007). Group deliberation may remedy some of the potential problems inherent to hypothetical valuation methods, including the often unrealistic assumption of well-defined and informed preferences among respondents (Schaafsma et al., 2018; Spash, 2007). After the group sessions, the survey interviews continued individually until the end of the session.

After finishing the survey with a set of socio-economic questions, respondents received 30 NAD (4.8 US$ PPP)[90] for their participation at the end of the session and were given the opportunity to donate to the previously presented vulture conservation project (identical to the one in the hypothetical WTP scenario). Respondents donated anonymously by putting money in an envelope and dropping it in a separate box, out of sight of the remaining survey participants and the enumerators. The respective study participant and donation amount could later be linked by an interview-ID that was written on the envelope.

In addition to measuring the respondents' conservation preferences on a non-hypothetical scale, the comparison of WTP bids and actual donations allows us to approximate the potential hypothetical bias in WTP bids. As indicated previously, the hypothetical bias states that individuals tend to overstate their WTP in hypothetical scenarios (Carson, 2012), e.g., due to demand effects (Tourangeau et al., 2000). Such demand effects could be argued to arise both within and outside conservancy villages. In conservancies, respondents might have seen an opportunity to provide a rationale for any kind of government funding (either of monetary nature or via in-kind benefits) in case they indicate positive conservation outcomes by responding accordingly to respective survey items. Outside villagers, on the other hand, might have had the interest to respond positive to these survey items to support potential future considerations of their village to become part of a conservancy, as CBNRM conservancies and

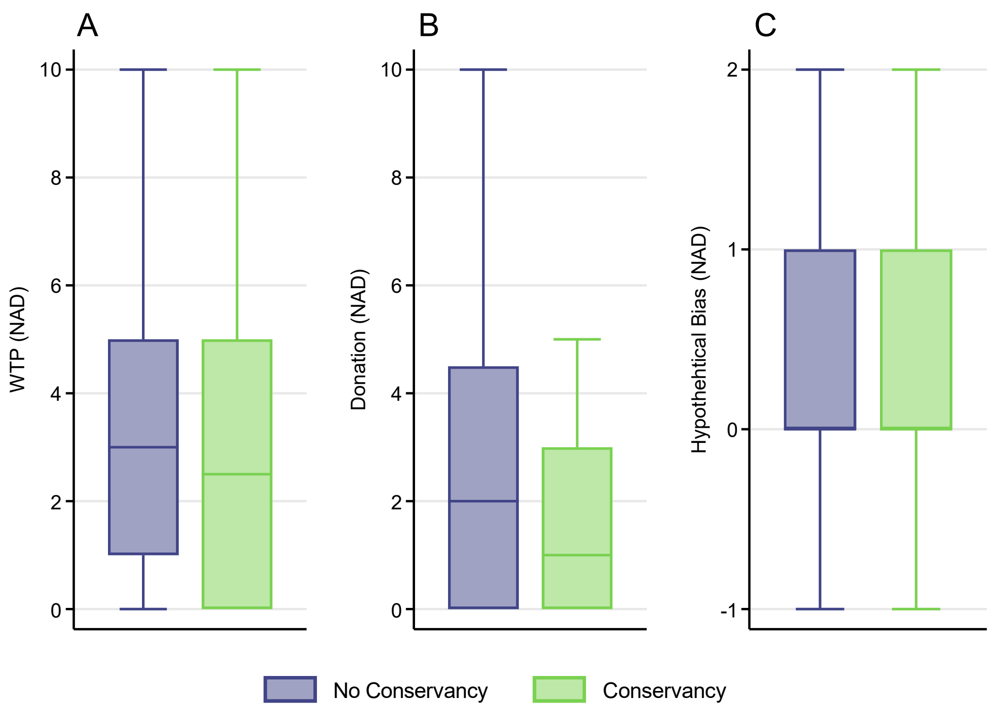
[90] At the time of the data collection, the monthly minimum wage for farm workers was 900 NAD. Respondents were made aware of the payment some days prior to the study (during the recruitment phase). This longer time horizon likely reduced the "windfall gain" effect compared to a "surprise" earning at the end of the interview, as participants had a longer time to internalize the money and make plans for it (Arkes et al., 1994)

their alleged benefits are well-known throughout the study area. To mitigate the impact of these demand effects on our conservation preference measures, we clearly stated not being associated with any kind of governmental agency or NGO that could provide funding and/or help in the establishment of new conservancy areas.

6.3.3. Results

Figure 6.2, Panel A and B illustrate the distribution of WTP and donations by conservancy status. The average WTP in non-conservancies and conservancies are almost identical (Mean = 4.81 vs. 4.75 NAD, SD=7.55 vs 7.96 NAD, Mann-Whitney-U (MWU) test p=0.23). However, the average donation from respondents living outside of conservancies is larger (Mean=3.16 vs. 2.39 NAD, SD=4.38 vs. 3.55 NAD, MWU p=0.08). Respondents in conservancies are more also likely to state a WTP of zero (31%) and donate nothing (44%) compared to the control villages (11% and 26%, respectively). These discrepancies are significantly different, as indicated by chi-squared tests (WTP: p=0.00, donation: p=0.02).

Figure 6.2 - A) Boxplot of WTP by Conservancy Status (outliers not displayed), B) Boxplot of Donations by Conservancy Status (outliers not displayed) C) Boxplot of Hypothetical Bias by Conservancy Status



In Table 6.3, we present Probit and Tobit regressions models where we control for additional socio-economic covariates (gender, age, household size, education, and monthly expenses). Here, we find that while respondents in conservancies are less likely to state a positive WTP and donate something, average donations are not significantly different between conservancy and non-conservancy villages.

Finding 1: There is evidence for lower conservation preferences within conservancies based on the hypothetical WTP and actual donation decisions. We observe larger shares of zero donations and zero WTP in conservancies.

Table 6.3 - Probit (DV: binary outcome positive WTP/donation yes/no) and Tobit model (DV: donation amount) Results Reported as Marginal Effects

	WTP			Donation		
	(1)	(2)	(3)	(4)	(5)	(6)
	Positive WTP (y/n)	Amount (NAD)	Amount (NAD)	Positive Donation (y/n)	Amount (NAD)	Amount (NAD)
Conservancy	-0.22**	-1.28	0.50	-0.21*	-0.89	-0.61
	[-0.35,-0.08]	[-2.98,0.43]	[-2.29,3.28]	[-0.40,-0.02]	[-2.11,0.34]	[-2.39,1.17]
Group Deliberation	-0.06	-1.84	-0.29	-0.02	-0.95	-0.70
	[-0.22,0.09]	[-4.14,0.45]	[-3.15,2.57]	[-0.14,0.11]	[-2.06,0.17]	[-2.09,0.69]
Conservancy x Group Deliberation			-3.20			-0.54
			[-7.07,0.67]			[-2.81,1.73]
Obs.	156	156	156	156	156	156
Left-censored		31	31		54	54
Right-censored		5	5		0	0
F-Stat		1.55	1.39		3.17	4.21
Chi2	45.80			18.08		
p-Value	0.00	0.14	0.19	0.03	0.00	0.00
Pseudo R2	0.20	0.02	0.02	0.07	0.03	0.03

Note: Robust standard errors clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1; controls: gender, age, age^2, number of children, household size, education (years of schooling), monthly expenses; Model 1 and 4 report the marginal effects of Probit regressions, while the other models are Tobit regressions. Full models are reported in the Appendix Tables E.C1, E.C2, and E.C4.

We can compute the hypothetical bias at the individual level by subtracting the donations from the WTP measure. A positive hypothetical bias thus indicates that respondents overstated their hypothetical WTP in relation to their actual decision. In our sample, 98 out of 156 (63%) respondents show no hypothetical bias. Overall, 45 respondents (29%) have a positive hypothetical bias and 13 (8%) respondents have a negative bias. See Figure 6.2, Panel C for the distribution of this variable by conservancy status.

On average however, actual donations are substantially lower than the stated WTP (2.80 vs. 4.78 NAD), and the share of respondents who donated nothing is larger than the share of respondents who stated a zero WTP (34.6% vs. 19.9%). The difference between average WTP and donations is statistically significant (Wilcoxon signed-rank test, p<0.01).

Using WTP as a measure for conservation preferences would be particularly challenged if the hypothetical bias would be more or less pronounced in conservancy villages. Here, this difference is not statistically significant (Mean=1.66 vs 2.36 NAD, SD=8.42 vs 8.07 NAD, MWU p= 0.75). These findings are also confirmed by Tobit regressions, including socio-economic controls and taking the absolute hypothetical bias as dependent variable (see Appendix Table E.C3).

Finding 2: There is a significant hypothetical bias, which does not differ significantly between conservancy and non-conservancy villages.

Next, we assess the impact of group deliberation on outcomes. We find that prior group deliberation has a negative effect on the average stated individual WTP and donation. The stated WTP is on average 2 NAD lower for the group deliberation treatment (3.76 vs. 5.8 NAD), and donations are on average 1.27 NAD lower for group compared to individual deliberation (2.17 vs. 3.44 NAD). However, these two differences are only statistically significant at the 0.1 level (MWU, WTP: p=0.09, donation: p=0.10) based on non-parametric tests and insignificant in regression analysis (see Table 6.3).[91] The hypothetical bias (measured as the difference between WTP and donations) is slightly lower under group deliberation (1.60 vs. 2.36 NAD), but this difference is not statistically significant (MWU, p=0.52).

Finding 3: We observe a tendency for lower conservation preferences if participants can deliberate in groups prior to the elicitation of WTP and donations.

Through Tobit regressions, we also assess whether group deliberation has different effects in- and outside of conservancies. In the respective models (see Table 6.3), we include an interaction between the group deliberation and conservancy variable that measures the additional impact of group deliberation in conservancies relative to the effect in non-conservancies. Despite a tendency that group deliberation lowers both WTP and donations in conservancies more than outside of conservancies, these effects are not significant.

[91] Group and individual deliberation treatments were randomly assigned at the individual level. Respondents in the two treatments had similar observable socio-economic characteristics (see Appendix Table E.C6 for details).

6.4. Discussion and Conclusion

This article provides the conceptualization of conservation preferences and a methodological contribution in describing and testing a way to measure them within the context of conservation projects, irrespective of the altered cost/benefit ratio affecting conservation behavior that is inherent to such projects.

Our case study in Namibia provides evidence that respondents in conservancies are both less likely to state a positive WTP and less likely to donate any money to the conservation cause presented to them within our survey. Based on the arguments presented throughout this article, these findings suggest lower average conservation preferences in CBRNM conservancies. A potential explanation for this finding might be that the conservancy members' average conservation preference has been undermined by the fact that initially promised economic benefits to the respective communities have failed to materialize over a timeframe of more than ten years. While evidence on such phenomena is still weak (Hayes et al., 2022), this explanation would relate our findings to the ongoing debate that certain policies, in particular those based on monetary incentives, have the potential to crowd-out conservation motivations (Ezzine-de-Blas et al., 2019; Rode et al., 2015).

One key merit of our approach is that it can help in investigating the potentially heterogenous demand effects in and outside of conservancies by providing a measure of hypothetical bias. We raised concerns that such demand effects might be larger within conservancies, where respondents may anticipate an increase in financial support if they provide answers in accordance with the "win-win" conservation narratives promoted by external actors (Cilliers et al., 2015). However, our results suggest that the hypothetical bias in conservancies is not different from the average bias we measured outside conservancies. From a practical perspective, this finding suggests that WTP elicitation within hypothetical scenarios might be sufficient to assess relative differences in conservation preferences between members and non-members of community-based conservation projects.

We additionally observe a tendency that group deliberation leads to both lower average WTP bids and donations, suggesting that individuals may struggle to form and express ad hoc preferences for unfamiliar goods, which is argued to be potentially remedied by group deliberation (Spash, 2007). However, group deliberation does not reduce the hypothetical bias. At the same time, the group deliberation treatment does not seem to have a significantly different impact within and outside of conservancies. Thus, if one wants to elicit the relative difference in conservation preferences in a similar context, individual deliberation might suffice.

Naturally, all findings from our Namibian case study have to be treated with caution. This is mainly due to the relatively small sample size and hence limited statistical power. Drawing robust conclusions on design considerations (WTP vs. donation; group vs. individual deliberation), would ideally be based on larger sample and multi-site studies covering different contextual variations. Naturally, one would ideally have applied a random assignment of the conservation intervention or employed longitudinal data that would allow to apply more robust (quasi)-experimental methods (Ferraro, 2009; Greenstone and Gayer, 2009). Nonetheless, we find few reasons to assume pre-existing differences between villages with respect to our outcome variables: First, the control villages are located in close proximity to the conservancy villages. On average, the control villages are located 18.4 km away from the nearest conservancy village (min. 6.3 km; max. 36.2 km). As a result, villages inside and outside of conservancies likely share similar socioeconomic and ecological conditions and thus equal potential for CBNRM success and economic development in general. Second, both our surveyed conservancies were initiated by community members rather than external actors (such as NGOs or the Namibian government) who could have selectively targeted certain communities. To the best of our knowledge, there have been no (failed) attempts to establish conservancies in any of our control villages. Thus, there might if at all be a positive selection bias stemming from the initial group of conservancy founders. Assuming a non-random establishment of conservancies (i.e., if environmental preferences were in, initially higher in the pre-CBNRM conservancy villages), the true conservancy effect would be biased upwards and thus be lower than what we observe based on our data.

We ultimately hope that the methodological contribution brought forward in this article can inform and inspire future studies that want to measure conservation preferences using similar methods. As indicated in the experimental design section of the article at hand, we argue that a careful design of the (hypothetical) donation cause is of crucial importance. One should aim to minimize the role of (in)direct "use values" (in the sense of a direct economic benefit of the donation cause to the respondents) and thus generate a ceteris paribus comparison between experimental groups or study sites. The fact that we observe a positive hypothetical bias in line with the broader contingent valuation literature, suggests that the donation task probably produces the more reliable measures.[92]

The outlined group deliberation prior to the individual WTP elicitation and donations appears to be a viable tool if respondents are less familiar with the donation cause or donations in general. Results from our case study regarding the lower WTP bids and donations following group deliberation might be a result of the realization that other group members in fact have relatively weak conservation preferences. Through this channel, one could argue that group deliberation could work as a means to mitigate potential demand effects if only employing individual elicitation. The potential issue of individual budget constraints heavily affecting both WTP bids and donations does not seem to be a significant issue in our study: We measure monthly household expenses, which are known to be typically highly correlated with household income, to not be correlated with stated WTP or actual donation behavior (see Appendix Tables E.C1 and E.C2). Thus, we find no evidence that would restrain us from recommending

[92] Meta-studies on hypothetical bias report that individuals overstate their WTP by a factor of 3 on average, although differences between studies are substantial depending on the type of good studied and the elicitation method applied (List and Gallet, 2001; Murphy et al., 2005; Schläpfer and Fischhoff, 2012). We find that respondents overstate their WTP by a factor of 1.71.

the conservation preference measurement approach we outlined and tested in this article. It provides a valuable and highly flexible alternative or complementary approach to previously established measurement tools, which either suffer from being prone to demand effects, being expensive to implement, and, most importantly, miss the quality of being able to address rather complex alterations to economic incentive structures that are inherent to community-based and/or incentive-based conservation interventions.

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Appendix A (Chapter 2)

A.A - Additional Tables

Table A.A1 – Main DCE Results in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters	Parameter means	Standard deviations of random parameters
Management fees	-0.501***		-0.551***		-0.614***		-0.672***	
	(0.026)		(0.031)		(0.032)		(0.039)	
EU Ecolabel	0.876***	0.928***	0.975***	1.031***	0.884***	0.938***	0.990***	1.050***
	(0.043)	(0.040)	(0.053)	(0.049)	(0.053)	(0.049)	(0.066)	(0.061)
Medium green shares	-0.382***	1.242***	-0.402***	1.323***	-0.493***	1.363***	-0.532***	1.470***
	(0.068)	(0.059)	(0.081)	(0.074)	(0.085)	(0.076)	(0.103)	(0.093)
High green shares	0.132***	-0.435***	0.143***	0.523***	0.140***	0.369***	0.150***	0.459***
	(0.033)	(0.055)	(0.041)	(0.064)	(0.040)	(0.073)	(0.049)	(0.086)
Historical returns	0.157***		0.169***		0.185***		0.201***	
	(0.010)		(0.013)		(0.013)		(0.016)	
Medium risk class	0.495***		0.527***		0.652***		0.675***	
	(0.063)		(0.076)		(0.081)		(0.099)	
Low-risk class	1.370***		1.536***		1.624***		1.838***	
	(0.047)		(0.058)		(0.060)		(0.077)	
Sample	Full	Full	Full	Full	Full	Full	Full	Full
Observations	36,192	36,192	27,393	27,393	25,512	25,512	19,269	19,269
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in preference space. Estimation results given in this table are based on eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A2 – Alternative Sample Specifications to Table 2.4 Model (1)

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.489***	1.095***	-0.475***	0.777***	-0.206**	1.111***
	(0.091)	(0.111)	(0.084)	(0.085)	(0.104)	(0.129)
EU Ecolabel * T1	0.597**		0.688***		0.606***	
	(0.255)		(0.266)		(0.218)	
Medium green shares * T1	0.361		0.340		0.407	
	(0.413)		(0.481)		(0.430)	
High green shares * T1	0.216		0.081		-0.005	
	(0.184)		(0.190)		(0.189)	
Historical returns * T1	0.160***		0.079*		0.135***	
	(0.047)		(0.046)		(0.042)	
Medium risk class * T1	0.645*		0.140		0.440	
	(0.361)		(0.365)		(0.357)	
Low risk class * T1	0.145		0.077		-0.005	
	(0.208)		(0.204)		(0.197)	
EU Ecolabel	1.105***	1.875***	0.842***	1.662***	0.955***	1.594***
	(0.175)	(0.160)	(0.186)	(0.164)	(0.153)	(0.117)
Medium green shares	-1.273***	2.125***	-1.338***	2.238***	-1.287***	2.189***
	(0.356)	(0.204)	(0.397)	(0.269)	(0.340)	(0.203)
High green shares	0.094	0.300	0.058	0.538***	0.095	0.650***
	(0.129)	(0.236)	(0.134)	(0.198)	(0.112)	(0.081)
Historical returns	0.180***		0.196***		0.178***	
	(0.033)		(0.032)		(0.022)	
Medium risk class	0.785***		0.979***		0.858***	
	(0.237)		(0.243)		(0.222)	
Low risk class	2.811***		2.828***		2.952***	
	(0.185)		(0.186)		(0.199)	
Sample	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C
Observations	10,977	10,977	10,344	10,344	7,758	7,758
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A3 – Alternative Sample Specifications to Table 2.4 Model (2)

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.495***	1.347	-0.527***	0.950***	-0.169***	1.480***
	(0.095)	(0.000)	(0.089)	(0.090)	(0.001)	(0.010)
EU Ecolabel * T2	1.089***		0.868***		0.902	
	(0.274)		(0.258)		(0.000)	
Medium green shares * T2	0.699*		0.619		0.660	
	(0.406)		(0.484)		(0.506)	
High green shares * T2	0.477**		0.435**		0.460***	
	(0.196)		(0.183)		(0.165)	
Historical returns * T2	0.241***		0.222***		0.263***	
	(0.047)		(0.050)		(0.032)	
Medium risk class * T2	1.636***		1.303***		1.529	
	(0.396)		(0.389)		(0.000)	
Low risk class * T2	0.835***		0.634***		0.461	
	(0.253)		(0.213)		(0.000)	
EU Ecolabel	1.082***	1.995***	0.922***	1.730***	0.870	1.919***
	(0.218)	(0.185)	(0.182)	(0.153)	(0.000)	(0.098)
Medium green shares	-1.512	2.159	-1.459***	2.262***	-1.582***	-2.278
	(0.000)	(0.000)	(0.402)	(0.285)	(0.419)	(0.000)
High green shares	0.039	-0.619***	0.032	0.313	0.055	-0.516
	(0.129)	(0.202)	(0.132)	(0.195)	(0.324)	(0.000)
Historical returns	0.174***		0.199***		0.169***	
	(0.030)		(0.034)		(0.055)	
Medium risk class	0.814***		1.007***		0.979	
	(0.256)		(0.257)		(0.000)	
Low risk class	2.926***		2.892***		3.180***	
	(0.178)		(0.190)		(0.208)	
Sample	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C
Observations	11,274	11,274	10,536	10,536	8,109	8,109
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A4 – Alternative Sample Specifications to Table 2.4 Model (3)

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.453***	1.289	-0.447***	0.840***	-0.109	1.268***
	(0.102)	(0.000)	(0.089)	(0.091)	(0.120)	(0.127)
EU Ecolabel * T2	0.436		0.327		0.304	
	(0.295)		(0.274)		(0.270)	
Medium green shares * T2	0.162		0.362		0.095	
	(0.440)		(0.487)		(0.519)	
High green shares * T2	0.185		0.320		0.429**	
	(0.204)		(0.197)		(0.212)	
Historical returns * T2	0.080		0.138***		0.118**	
	(0.051)		(0.048)		(0.057)	
Medium risk class * T2	0.883**		1.103***		1.002**	
	(0.398)		(0.399)		(0.421)	
Low risk class * T2	0.647***		0.509**		0.587**	
	(0.238)		(0.226)		(0.244)	
EU Ecolabel	1.772***	2.065***	1.493***	1.778***	1.475***	1.842***
	(0.181)	(0.212)	(0.195)	(0.168)	(0.194)	(0.187)
Medium green shares	-0.808**	2.113***	-1.070**	2.236***	-0.961**	2.033***
	(0.354)	(0.218)	(0.417)	(0.259)	(0.424)	(0.250)
High green shares	0.302**	0.767***	0.137	0.608***	0.151	0.661***
	(0.142)	(0.117)	(0.145)	(0.228)	(0.166)	(0.181)
Historical returns	0.337***		0.276***		0.308***	
	(0.035)		(0.033)		(0.035)	
Medium risk class	1.549***		1.175***		1.407***	
	(0.271)		(0.274)		(0.267)	
Low risk class	3.068***		2.943***		2.975***	
	(0.204)		(0.198)		(0.215)	
Sample	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1
Observations	10,899	10,899	10,176	10,176	7,611	7,611
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A5 – Table 2.4 Model (1) Estimations in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.537***		-0.565***		-0.622***		-0.640***	
	(0.042)		(0.050)		(0.051)		(0.061)	
EU Ecolabel * T1	0.392***		0.390***		0.424***		0.415**	
	(0.124)		(0.144)		(0.150)		(0.173)	
Med. green shares * T1	0.193		0.239		0.196		0.200	
	(0.197)		(0.235)		(0.246)		(0.297)	
High green shares * T1	0.140		0.133		0.008		-0.027	
	(0.100)		(0.119)		(0.115)		(0.137)	
Historical returns * T1	0.069***		0.096***		0.059*		0.085**	
	(0.026)		(0.031)		(0.031)		(0.039)	
Medium risk class * T1	0.235		0.455**		0.189		0.348	
	(0.185)		(0.223)		(0.232)		(0.283)	
Low risk class * T1	0.134		0.191		0.197		0.201	
	(0.132)		(0.158)		(0.160)		(0.194)	
EU Ecolabel	0.554***	0.941***	0.612***	0.980***	0.506***	0.942***	0.553***	0.929***
	(0.086)	(0.065)	(0.099)	(0.079)	(0.102)	(0.080)	(0.114)	(0.095)
Medium green shares	-0.565***	1.314***	-0.686***	1.394***	-0.724***	-1.449***	-0.874***	1.581***
	(0.133)	(0.100)	(0.156)	(0.122)	(0.165)	(0.130)	(0.192)	(0.160)
High green shares	0.030	0.458***	-0.011	0.471***	0.053	-0.290**	0.004	0.266
	(0.067)	(0.082)	(0.076)	(0.106)	(0.077)	(0.126)	(0.084)	(0.167)
Historical returns	0.099***		0.087***		0.113***		0.096***	
	(0.019)		(0.023)		(0.023)		(0.027)	
Medium risk class	0.281**		0.123		0.407***		0.232	
	(0.123)		(0.141)		(0.151)		(0.177)	
Low risk class	1.273***		1.336***		1.484***		1.591***	
	(0.100)		(0.119)		(0.124)		(0.150)	
Sample	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C	T1 & C
Observations	14,640	14,640	10,977	10,977	10,344	10,344	7,758	7,758
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the preference space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A6 – Table 2.4 Model (2) Estimations in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.469***		-0.494***		-0.582***		-0.608***	
	(0.042)		(0.050)		(0.051)		(0.061)	
EU Ecolabel * T2	0.481***		0.519***		0.517***		0.537***	
	(0.121)		(0.144)		(0.141)		(0.162)	
Med. green shares * T2	0.290		0.369*		0.321		0.400	
	(0.183)		(0.219)		(0.234)		(0.282)	
High green shares * T2	0.121		0.207*		0.200*		0.321**	
	(0.094)		(0.112)		(0.112)		(0.134)	
Historical returns * T2	0.098***		0.127***		0.120***		0.166***	
	(0.025)		(0.031)		(0.031)		(0.038)	
Medium risk class * T2	0.528***		0.734***		0.648***		0.901***	
	(0.182)		(0.217)		(0.236)		(0.282)	
Low risk class * T2	0.318**		0.407**		0.382**		0.453**	
	(0.136)		(0.162)		(0.167)		(0.200)	
EU Ecolabel	0.487***	0.888***	0.536***	1.014***	0.467***	0.861***	0.516***	0.946***
	(0.084)	(0.066)	(0.098)	(0.080)	(0.101)	(0.082)	(0.116)	(0.098)
Medium green shares	-0.628***	1.236***	-0.760***	1.324***	-0.764***	1.412***	-0.900***	1.511***
	(0.130)	(0.096)	(0.152)	(0.115)	(0.161)	(0.121)	(0.189)	(0.152)
High green shares	0.005	0.355***	-0.046	0.423***	0.034	0.354***	-0.024	0.419***
	(0.066)	(0.091)	(0.075)	(0.102)	(0.076)	(0.114)	(0.085)	(0.131)
Historical returns	0.080***		0.065***		0.102***		0.084***	
	(0.019)		(0.022)		(0.023)		(0.028)	
Medium risk class	0.192		0.036		0.355**		0.189	
	(0.120)		(0.138)		(0.149)		(0.176)	
Low risk class	1.199***		1.275***		1.437***		1.569***	
	(0.097)		(0.117)		(0.122)		(0.151)	
Sample	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C	T2 & C
Observations	14,712	14,712	11,274	11,274	10,536	10,536	8,109	8,109
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the preference space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A7 – Table 2.4 Model (3) Estimations in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.477***		-0.529***		-0.598***		-0.665***	
	(0.042)		(0.050)		(0.052)		(0.064)	
EU Ecolabel * T2	0.107		0.133		0.106		0.130	
	(0.126)		(0.155)		(0.155)		(0.189)	
Med. green shares * T2	0.096		0.126		0.119		0.183	
	(0.196)		(0.237)		(0.258)		(0.313)	
High green shares * T2	-0.014		0.082		0.194		0.357**	
	(0.101)		(0.126)		(0.120)		(0.154)	
Historical returns * T2	0.032		0.034		0.064*		0.085**	
	(0.027)		(0.033)		(0.033)		(0.042)	
Medium risk class * T2	0.303		0.293		0.477*		0.574*	
	(0.202)		(0.249)		(0.263)		(0.331)	
Low risk class * T2	0.193		0.226		0.191		0.260	
	(0.137)		(0.167)		(0.169)		(0.211)	
EU Ecolabel	0.875***	0.934***	0.970***	1.057***	0.903***	0.957***	1.004***	1.065***
	(0.091)	(0.065)	(0.113)	(0.081)	(0.117)	(0.083)	(0.148)	(0.103)
Medium green shares	-0.434***	1.255***	-0.479***	1.355***	-0.542***	1.419***	-0.650***	1.580***
	(0.150)	(0.090)	(0.179)	(0.108)	(0.188)	(0.111)	(0.228)	(0.137)
High green shares	0.139*	-0.423***	0.095	0.543***	0.045	-0.355***	-0.032	0.481***
	(0.076)	(0.090)	(0.095)	(0.101)	(0.089)	(0.122)	(0.114)	(0.139)
Historical returns	0.148***		0.170***		0.163***		0.186***	
	(0.021)		(0.027)		(0.026)		(0.034)	
Medium risk class	0.432***		0.531***		0.562***		0.620**	
	(0.145)		(0.182)		(0.185)		(0.241)	
Low risk class	1.345***		1.511***		1.665***		1.856***	
	(0.097)		(0.123)		(0.123)		(0.162)	
Sample	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1	T2 & T1
Observations	14,424	14,424	10,899	10,899	10,176	10,176	7,611	7,611
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the preference space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group. Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A8 – Effects of the First Two (Information) Treatments with Pooled Treatment Groups

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.706***	0.913***	-0.464***	1.238***	-0.468***	0.855***	-0.174	1.255***
	(0.068)	(0.068)	(0.083)	(0.104)	(0.072)	(0.073)	(0.110)	(0.036)
EU Ecolabel * Info	0.862***		0.833***		0.763***		0.723***	
	(0.241)		(0.234)		(0.235)		(0.178)	
Med. green shares * Info	0.469		0.371		0.371		0.667	
	(0.401)		(0.402)		(0.398)		(0.000)	
High green shares * Info	0.309*		0.389**		0.209		0.301*	
	(0.162)		(0.163)		(0.169)		(0.166)	
Historical returns * Info	0.165***		0.201***		0.137***		0.210***	
	(0.039)		(0.044)		(0.039)		(0.020)	
Medium risk class * Info	0.788***		1.158***		0.691**		1.072	
	(0.302)		(0.333)		(0.309)		(0.000)	
Low risk class * Info	0.382**		0.489***		0.361*		0.292***	
	(0.181)		(0.185)		(0.185)		(0.087)	
EU Ecolabel	1.081***	2.018***	1.139***	2.070***	0.854***	1.712***	0.966***	1.761***
	(0.192)	(0.145)	(0.181)	(0.136)	(0.179)	(0.143)	(0.190)	(0.129)
Medium green shares	-1.271***	2.217***	-1.199***	2.261***	-1.330***	2.326***	-1.636	2.274
	(0.341)	(0.225)	(0.399)	(0.247)	(0.369)	(0.213)	(0.000)	(0.000)
High green shares	0.048	0.667***	0.034	0.679***	0.076	0.665***	0.039	0.693***
	(0.132)	(0.215)	(0.134)	(0.174)	(0.137)	(0.155)	(0.131)	(0.083)
Historical returns	0.196***		0.182***		0.206***		0.157***	
	(0.031)		(0.036)		(0.031)		(0.023)	
Medium risk class	0.894***		0.841***		1.030***		0.782	
	(0.233)		(0.271)		(0.242)		(0.000)	
Low risk class	2.884***		2.889***		2.847***		2.990***	
	(0.178)		(0.168)		(0.178)		(0.057)	
Sample	C, T1 & T2	C, T1 & T2	C, T1 & T2	C, T1 & T2	C, T1 & T2	C, T1 & T2	C, T1 & T2	C, T1 & T2
Observations	21,888	21,888	16,575	16,575	15,528	15,528	11,739	11,739
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interaction terms treatment dummies indicating a respondent's assignment to the respective treatment group (in this case, either T1 or T2). Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A9 – Table 2.5 Models in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.502***		-0.551***		-0.617***		-0.673***	
	(0.026)		(0.031)		(0.032)		(0.039)	
EU Ecolabel * Pie	0.186**		0.205**		0.212**		0.245**	
	(0.080)		(0.097)		(0.099)		(0.119)	
Med. green shares * Pie	0.131		0.183		0.115		0.176	
	(0.126)		(0.151)		(0.156)		(0.190)	
High green shares * Pie	0.087		0.136*		0.077		0.126	
	(0.065)		(0.079)		(0.077)		(0.095)	
Historical returns * Pie	0.038**		0.038*		0.045**		0.047*	
	(0.017)		(0.021)		(0.021)		(0.026)	
Medium risk class * Pie	0.045		0.090		-0.038		-0.011	
	(0.117)		(0.138)		(0.147)		(0.177)	
Low risk class * Pie	-0.020		0.028		-0.086		-0.028	
	(0.083)		(0.100)		(0.103)		(0.126)	
EU Ecolabel	0.803***	0.930***	0.894***	1.032***	0.803***	0.940***	0.894***	1.051***
	(0.052)	(0.040)	(0.063)	(0.049)	(0.063)	(0.049)	(0.077)	(0.061)
Medium green shares	-0.431***	1.235***	-0.474***	1.321***	-0.536***	1.364***	-0.601***	1.470***
	(0.082)	(0.058)	(0.098)	(0.074)	(0.103)	(0.075)	(0.123)	(0.093)
High green shares	0.099**	0.432***	0.090*	0.521***	0.112**	0.365***	0.101*	0.456***
	(0.042)	(0.055)	(0.051)	(0.064)	(0.049)	(0.073)	(0.060)	(0.086)
Historical returns	0.142***		0.154***		0.168***		0.183***	
	(0.012)		(0.015)		(0.015)		(0.019)	
Medium risk class	0.480***		0.492***		0.670***		0.680***	
	(0.080)		(0.097)		(0.103)		(0.128)	
Low risk class	1.380***		1.526***		1.662***		1.851***	
	(0.059)		(0.073)		(0.075)		(0.095)	
Sample	Full	Full	Full	Full	Full	Full	Full	Full
Observations	36,192	36,192	27,393	27,393	25,512	25,512	19,269	19,269
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the preference space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interactions with treatment dummies indicating a respondent's assignment to one of the two relevant treatment groups (Pie: T3 or T4). Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A10 – Table 2.6 Models Estimated in Preference Space

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.519***		-0.597***		-0.649***		-0.751***	
	(0.041)		(0.050)		(0.049)		(0.062)	
EU Ecolabel * T3	-0.026		0.087		0.241		0.449**	
	(0.126)		(0.155)		(0.158)		(0.197)	
Med. green shares * T3	0.080		0.114		0.165		0.212	
	(0.199)		(0.239)		(0.240)		(0.299)	
High green shares * T3	0.149		0.224*		0.156		0.263*	
	(0.102)		(0.126)		(0.123)		(0.157)	
Historical returns * T3	-0.004		0.011		0.022		0.063	
	(0.026)		(0.033)		(0.033)		(0.042)	
Medium risk class * T3	-0.034		0.020		0.171		0.433	
	(0.179)		(0.209)		(0.221)		(0.264)	
Low risk class * T3	-0.121		-0.187		-0.150		-0.176	
	(0.126)		(0.154)		(0.157)		(0.195)	
EU Ecolabel	1.023***	0.936***	1.115***	1.066***	0.931***	0.973***	1.024***	1.180***
	(0.097)	(0.059)	(0.120)	(0.075)	(0.119)	(0.071)	(0.150)	(0.098)
Medium green shares	-0.301**	1.209***	-0.259	1.271***	-0.409**	1.282***	-0.352	1.356***
	(0.148)	(0.096)	(0.175)	(0.119)	(0.188)	(0.116)	(0.221)	(0.149)
High green shares	0.117*	0.456***	0.134	0.586***	0.123	0.397***	0.134	0.560***
	(0.071)	(0.087)	(0.088)	(0.101)	(0.087)	(0.118)	(0.113)	(0.136)
Historical returns	0.188***		0.202***		0.213***		0.226***	
	(0.021)		(0.026)		(0.025)		(0.033)	
Medium risk class	0.571***		0.643***		0.601***		0.590***	
	(0.137)		(0.153)		(0.164)		(0.187)	
Low risk class	1.442***		1.700***		1.696***		2.025***	
	(0.101)		(0.120)		(0.125)		(0.153)	
Sample	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4	T3 & T4
Observations	14,304	14,304	10,818	10,818	9,984	9,984	7,530	7,530
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Note: Simulated maximum likelihood estimations with 1000 Halton draws in the WTP space. Estimation results given in this table are based on a total of eight choice sets per respondent. The table reports parameter estimates for all explanatory variables based on equity fund attributes and their respective interactions with treatment dummies indicating a respondent's assignment to the relevant treatment group (T3). Standard deviations for random parameter estimates are given in the respective second column of each model. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on robust z-statistics. 'No choice' refers to the subsample of observations, in which respondents indicated that they actually would have preferred to choose none of the options made available to them. 'Rushers' refers to the subsample of observations, in which respondents either failed to answer at least one of the DCE quiz questions correctly and/or spent less than 60 seconds on the DCE introduction page.

Table A.A11 – Alternative Sample Specifications to Table 2.7 Model (1) – Ecolabel Interaction

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.422***	1.082***	-0.476***	0.773***	-0.201***	1.018***
	(0.066)	(0.017)	(0.059)	(0.058)	(0.078)	(0.091)
Gender interaction	-0.542***		-0.412**		-0.393**	
	(0.176)		(0.161)		(0.196)	
Age interaction	-0.032***		-0.018*		-0.017	
	(0.010)		(0.010)		(0.011)	
Education interaction	-0.463***		-0.359**		-0.331*	
	(0.163)		(0.161)		(0.182)	
Income class interaction	-0.069**		-0.050**		-0.054**	
	(0.027)		(0.025)		(0.027)	
Risk index interaction	0.135*		-0.032		0.079	
	(0.074)		(0.070)		(0.082)	
Financial exp. interaction	-0.331**		-0.204		-0.287	
	(0.164)		(0.161)		(0.183)	
Gen. trust interaction	-0.151*		-0.128*		-0.137*	
	(0.080)		(0.066)		(0.079)	
Inst. trust interaction	0.121		0.160**		0.165*	
	(0.074)		(0.074)		(0.085)	
Patience interaction	-0.111		-0.155**		-0.144	
	(0.079)		(0.074)		(0.096)	
Altruism interaction	0.175***		0.204***		0.185**	
	(0.061)		(0.060)		(0.076)	
Ecol. Politics interaction	0.458***		0.357***		0.415***	
	(0.060)		(0.059)		(0.063)	
NEP interaction	0.026		-0.004		-0.022	
	(0.069)		(0.066)		(0.070)	
EU Ecolabel	3.095***	1.581***	2.305***	1.395***	2.346***	1.442***
	(0.353)	(0.120)	(0.346)	(0.106)	(0.360)	(0.120)
Medium green shares	-0.778***	2.109***	-1.061***	2.301***	-0.933***	2.093***
	(0.206)	(0.170)	(0.227)	(0.190)	(0.254)	(0.236)
High green shares	0.341***	0.875***	0.221***	0.597***	0.231***	0.679***
	(0.070)	(0.124)	(0.070)	(0.160)	(0.085)	(0.244)
Historical returns	0.325***		0.323***		0.316***	
	(0.016)		(0.016)		(0.018)	
Medium risk class	1.372***		1.278***		1.224***	
	(0.134)		(0.134)		(0.156)	
Low risk class	3.054***		2.972***		3.036***	
	(0.120)		(0.115)		(0.128)	
Observations	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Table A.A12 – Alternative Sample Specifications to Table 2.7 Model (2) – High Green Shares Interaction

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.408***	1.092***	-0.475***	0.772***	-0.174***	1.062***
	(0.066)	(0.077)	(0.059)	(0.058)	(0.034)	(0.002)
Gender interaction	-0.088		-0.024		-0.098	
	(0.136)		(0.129)		(0.150)	
Age interaction	-0.003		0.008		0.007	
	(0.009)		(0.008)		(0.009)	
Education interaction	-0.144		-0.214*		-0.210	
	(0.135)		(0.129)		(0.141)	
Income class interaction	-0.028		0.002		-0.020	
	(0.021)		(0.021)		(0.023)	
Risk index interaction	0.133**		0.017		0.104	
	(0.057)		(0.055)		(0.065)	
Financial exp. interaction	-0.013		-0.077		-0.084	
	(0.136)		(0.131)		(0.146)	
Gen. trust interaction	0.010		0.014		-0.019	
	(0.054)		(0.054)		(0.059)	
Inst. trust interaction	0.069		0.133**		0.119*	
	(0.063)		(0.059)		(0.065)	
Patience interaction	-0.105		0.031		-0.075	
	(0.064)		(0.056)		(0.065)	
Altruism interaction	0.034		0.047		0.032	
	(0.052)		(0.048)		(0.056)	
Ecol. Politics interaction	0.135***		0.093**		0.143***	
	(0.050)		(0.047)		(0.049)	
NEP interaction	0.033		0.061		0.043	
	(0.052)		(0.052)		(0.057)	
EU Ecolabel	1.745***	1.883***	1.483***	1.621***	1.496***	1.655***
	(0.096)	(0.113)	(0.092)	(0.111)	(0.093)	(0.109)
Medium green shares	-0.802***	2.248***	-1.043***	2.279***	-0.992***	2.299***
	(0.203)	(0.185)	(0.230)	(0.201)	(0.246)	(0.187)
High green shares	0.683**	0.794***	-0.090	0.553***	0.285	0.721***
	(0.281)	(0.126)	(0.275)	(0.153)	(0.311)	(0.096)
Historical returns	1.745***	1.883***	1.483***	1.621***	1.496***	1.655***
	(0.096)	(0.113)	(0.092)	(0.111)	(0.093)	(0.109)
Medium risk class	-0.802***	2.248***	-1.043***	2.279***	-0.992***	2.299***
	(0.203)	(0.185)	(0.230)	(0.201)	(0.246)	(0.187)
Low risk class	0.683**	0.794***	-0.090	0.553***	0.285	0.721***
	(0.281)	(0.126)	(0.275)	(0.153)	(0.311)	(0.096)
Observations	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Table A.A13 – Alternative Sample Specifications to Table 2.7 Model (3) – Returns Interaction

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.378***	1.096***	-0.468***	0.797***	-0.146**	1.081***
	(0.068)	(0.078)	(0.059)	(0.058)	(0.072)	(0.085)
Gender interaction	0.133***		0.112***		0.136	
	(0.023)		(0.023)		(0.000)	
Age interaction	0.002**		0.001		0.001	
	(0.001)		(0.001)		(0.001)	
Education interaction	-0.029		-0.008		-0.021	
	(0.021)		(0.022)		(0.026)	
Income class interaction	0.006*		0.006*		0.006	
	(0.003)		(0.003)		(0.004)	
Risk index interaction	-0.009		0.009		-0.008	
	(0.009)		(0.010)		(0.010)	
Financial exp. interaction	0.126***		0.084***		0.133***	
	(0.022)		(0.022)		(0.024)	
Gen. trust interaction	0.031***		0.032***		0.035***	
	(0.009)		(0.009)		(0.009)	
Inst. trust interaction	-0.010		-0.024**		-0.026**	
	(0.010)		(0.010)		(0.010)	
Patience interaction	0.005		0.012		0.009	
	(0.010)		(0.011)		(0.010)	
Altruism interaction	-0.015*		-0.024***		-0.009	
	(0.009)		(0.009)		(0.008)	
Ecol. Politics interaction	-0.037***		-0.020**		-0.030	
	(0.009)		(0.008)		(0.000)	
NEP interaction	0.004		0.006		0.009	
	(0.009)		(0.009)		(0.011)	
EU Ecolabel	1.718***	1.759***	1.522***	1.525***	1.534***	1.563***
	(0.098)	(0.124)	(0.091)	(0.107)	(0.096)	(0.116)
Medium green shares	-0.646***	1.988***	-0.917***	2.038***	-0.807***	1.950***
	(0.200)	(0.149)	(0.215)	(0.159)	(0.208)	(0.144)
High green shares	0.397***	0.864***	0.271***	0.527***	0.301***	0.700***
	(0.069)	(0.111)	(0.068)	(0.136)	(0.072)	(0.118)
Historical returns	0.163***		0.201***		0.154***	
	(0.044)		(0.048)		(0.043)	
Medium risk class	1.369***		1.269***		1.255***	
	(0.119)		(0.133)		(0.134)	
Low risk class	3.049***		2.984***		3.058***	
	(0.119)		(0.114)		(0.118)	
Observations	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Table A.A14 – Alternative Sample Specifications to Table 2.7 Model (4) – Lowest Risk Class Interaction

	(1)		(2)		(3)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.405***	0.939***	-0.451***	0.722***	-0.153**	1.018***
	(0.064)	(0.077)	(0.058)	(0.059)	(0.075)	(0.095)
Gender interaction	0.459***		0.151		0.214	
	(0.139)		(0.128)		(0.149)	
Age interaction	-0.001		0.003		0.002	
	(0.008)		(0.009)		(0.009)	
Education interaction	0.037		-0.058		-0.200	
	(0.142)		(0.131)		(0.146)	
Income class interaction	0.009		-0.025		-0.000	
	(0.023)		(0.021)		(0.022)	
Risk index interaction	-0.324***		-0.190***		-0.202***	
	(0.067)		(0.056)		(0.062)	
Financial exp. interaction	-0.358**		-0.299**		-0.399***	
	(0.144)		(0.134)		(0.148)	
Gen. trust interaction	-0.154***		-0.136**		-0.126**	
	(0.059)		(0.055)		(0.060)	
Inst. trust interaction	-0.017		0.036		-0.018	
	(0.075)		(0.061)		(0.071)	
Patience interaction	0.066		0.026		-0.100	
	(0.067)		(0.062)		(0.073)	
Altruism interaction	-0.007		0.006		0.052	
	(0.057)		(0.050)		(0.062)	
Ecol. Politics interaction	-0.052		-0.066		-0.042	
	(0.052)		(0.050)		(0.053)	
NEP interaction	0.036		0.033		-0.014	
	(0.055)		(0.054)		(0.059)	
EU Ecolabel	1.736***	1.857***	1.489***	1.611***	1.485***	
	(0.099)	(0.124)	(0.091)	(0.109)	(0.098)	
Medium green shares	-0.688***	2.150***	-0.967***	2.221***	-0.884***	
	(0.208)	(0.187)	(0.223)	(0.182)	(0.231)	
High green shares	0.341***	0.924***	0.227***	0.603***	0.228***	
	(0.073)	(0.114)	(0.068)	(0.128)	(0.076)	
Historical returns	0.322***		0.326***		0.314***	
	(0.017)		(0.016)		(0.016)	
Medium risk class	1.300***		1.272***		1.234***	
	(0.133)		(0.131)		(0.145)	
Low risk class	2.749***		2.988***		3.249***	
	(0.320)		(0.302)		(0.344)	
Observations	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	NO	NO	NO	NO

Table A.A15 – Table 2.7 Model (1) Estimated in Preference Space – Ecolabel Interaction

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.514***		-0.565***		-0.610***		-0.670***	
	(0.029)		(0.035)		(0.035)		(0.043)	
Gender interaction	-0.246***		-0.287***		-0.210**		-0.227**	
	(0.074)		(0.087)		(0.088)		(0.105)	
Age interaction	-0.013***		-0.018***		-0.010*		-0.011*	
	(0.004)		(0.006)		(0.005)		(0.007)	
Education interaction	-0.214***		-0.197**		-0.171*		-0.184*	
	(0.074)		(0.087)		(0.089)		(0.106)	
Income class interaction	-0.030**		-0.037**		-0.024		-0.030*	
	(0.013)		(0.015)		(0.015)		(0.018)	
Risk index interaction	0.021		0.052		-0.015		0.052	
	(0.032)		(0.038)		(0.037)		(0.044)	
Financial exp. interaction	-0.131*		-0.202**		-0.154*		-0.237**	
	(0.075)		(0.088)		(0.088)		(0.104)	
Gen. trust interaction	-0.070**		-0.060		-0.073**		-0.072*	
	(0.032)		(0.037)		(0.037)		(0.043)	
Inst. trust interaction	0.062*		0.066		0.098**		0.104**	
	(0.036)		(0.042)		(0.043)		(0.050)	
Patience interaction	-0.025		-0.042		-0.062*		-0.074	
	(0.031)		(0.039)		(0.038)		(0.048)	
Altruism interaction	0.090***		0.080**		0.105***		0.097**	
	(0.029)		(0.034)		(0.033)		(0.039)	
Ecol. Politics interaction	0.201***		0.240***		0.201***		0.264***	
	(0.028)		(0.032)		(0.033)		(0.039)	
NEP interaction	0.044		0.047		0.008		0.015	
	(0.031)		(0.036)		(0.038)		(0.045)	
EU Ecolabel	1.359***	0.828***	1.670***	0.908***	1.251***	0.816***	1.479***	0.897***
	(0.150)	(0.043)	(0.188)	(0.055)	(0.180)	(0.053)	(0.222)	(0.067)
Medium green shares	-0.434***	1.318***	-0.437***	1.388***	-0.574***	1.430***	-0.598***	1.539***
	(0.078)	(0.069)	(0.093)	(0.085)	(0.099)	(0.084)	(0.118)	(0.106)
High green shares	0.144***	0.446***	0.158***	0.555***	0.124***	0.369***	0.137**	0.492***
	(0.037)	(0.060)	(0.046)	(0.070)	(0.044)	(0.082)	(0.055)	(0.093)
Historical returns	0.165***		0.177***		0.188***		0.206***	
	(0.012)		(0.014)		(0.015)		(0.018)	
Medium risk class	0.535***		0.550***		0.642***		0.657***	
	(0.071)		(0.086)		(0.090)		(0.111)	
Low risk class	1.419***		1.592***		1.652***		1.882***	
	(0.053)		(0.066)		(0.066)		(0.085)	
Observations	29,136	29,136	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Table A.A16 – Table 2.7 Model (2) Estimated in Preference Space – High Green Shares Interaction

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.514***		-0.567***		-0.610***		-0.674***	
	(0.029)		(0.035)		(0.035)		(0.043)	
Gender interaction	-0.013		-0.015		0.022		-0.003	
	(0.064)		(0.081)		(0.074)		(0.095)	
Age interaction	-0.004		-0.004		0.003		0.002	
	(0.004)		(0.005)		(0.005)		(0.006)	
Education interaction	-0.070		-0.099		-0.103		-0.145	
	(0.064)		(0.078)		(0.076)		(0.094)	
Income class interaction	-0.005		-0.013		-0.002		-0.013	
	(0.010)		(0.013)		(0.012)		(0.016)	
Risk index interaction	0.021		0.034		0.014		0.050	
	(0.027)		(0.034)		(0.031)		(0.040)	
Financial exp. interaction	0.027		0.038		-0.024		-0.013	
	(0.064)		(0.078)		(0.074)		(0.094)	
Gen. trust interaction	0.028		0.016		0.023		0.004	
	(0.029)		(0.034)		(0.034)		(0.040)	
Inst. trust interaction	0.026		0.040		0.067*		0.090**	
	(0.030)		(0.037)		(0.036)		(0.046)	
Patience interaction	0.014		-0.036		0.020		-0.036	
	(0.027)		(0.032)		(0.033)		(0.040)	
Altruism interaction	0.027		0.022		0.043		0.033	
	(0.025)		(0.030)		(0.029)		(0.036)	
Ecol. Politics interaction	0.065***		0.098***		0.056**		0.091***	
	(0.024)		(0.029)		(0.028)		(0.035)	
NEP interaction	0.025		0.026		0.036		0.038	
	(0.026)		(0.032)		(0.030)		(0.038)	
EU Ecolabel	0.882***	0.938***	0.987***	1.046***	0.874***	0.934***	0.995***	1.044***
	(0.048)	(0.044)	(0.060)	(0.055)	(0.059)	(0.054)	(0.075)	(0.068)
Medium green shares	-0.435***	1.324***	-0.440***	1.403***	-0.574***	1.439***	-0.598***	1.557***
	(0.078)	(0.070)	(0.094)	(0.085)	(0.099)	(0.086)	(0.119)	(0.107)
High green shares	0.165	0.432***	0.279*	0.539***	-0.053	-0.341***	0.136	0.466***
	(0.134)	(0.061)	(0.164)	(0.071)	(0.155)	(0.087)	(0.197)	(0.097)
Historical returns	0.165***		0.177***		0.188***		0.207***	
	(0.012)		(0.014)		(0.015)		(0.018)	
Medium risk class	0.542***		0.557***		0.654***		0.666***	
	(0.071)		(0.086)		(0.091)		(0.112)	
Low risk class	1.420***		1.599***		1.654***		1.890***	
	(0.053)		(0.067)		(0.066)		(0.086)	
Observations	29,136	29,136	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Table A.A17 – Table 2.7 Model (3) Estimated in Preference Space – Returns Interaction

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.517***		-0.570***		-0.614***		-0.679***	
	(0.029)		(0.035)		(0.035)		(0.043)	
Gender interaction	0.056***		0.065***		0.061***		0.071***	
	(0.013)		(0.015)		(0.016)		(0.019)	
Age interaction	0.001		0.002		0.000		0.000	
	(0.001)		(0.001)		(0.001)		(0.001)	
Education interaction	-0.013		-0.024		-0.011		-0.021	
	(0.013)		(0.016)		(0.016)		(0.020)	
Income class interaction	0.002		0.004		0.003		0.005	
	(0.002)		(0.002)		(0.003)		(0.003)	
Risk index interaction	-0.001		-0.005		0.004		-0.005	
	(0.005)		(0.007)		(0.007)		(0.008)	
Financial exp. interaction	0.038***		0.054***		0.041***		0.070***	
	(0.013)		(0.015)		(0.015)		(0.019)	
Gen. trust interaction	0.009		0.014**		0.015**		0.020**	
	(0.006)		(0.007)		(0.007)		(0.008)	
Inst. trust interaction	-0.002		-0.006		-0.010		-0.017*	
	(0.006)		(0.007)		(0.007)		(0.009)	
Patience interaction	0.002		0.002		0.002		0.004	
	(0.006)		(0.007)		(0.007)		(0.009)	
Altruism interaction	-0.007		-0.007		-0.012**		-0.008	
	(0.005)		(0.006)		(0.006)		(0.007)	
Ecol. Politics interaction	-0.013***		-0.018***		-0.011*		-0.020***	
	(0.005)		(0.006)		(0.006)		(0.008)	
NEP interaction	-0.003		-0.005		0.004		0.004	
	(0.005)		(0.007)		(0.007)		(0.008)	
EU Ecolabel	0.891***	0.893***	0.995***	0.980***	0.890***	0.884***	1.016***	0.970***
	(0.048)	(0.044)	(0.060)	(0.056)	(0.059)	(0.054)	(0.075)	(0.070)
Medium green shares	-0.401***	1.262***	-0.393***	1.306***	-0.525***	1.357***	-0.535***	1.453***
	(0.079)	(0.071)	(0.094)	(0.086)	(0.098)	(0.085)	(0.118)	(0.107)
High green shares	0.153***	0.455***	0.172***	0.566***	0.140***	0.388***	0.165***	0.511***
	(0.038)	(0.060)	(0.047)	(0.070)	(0.045)	(0.079)	(0.056)	(0.091)
Historical returns	0.109***		0.095***		0.143***		0.142***	
	(0.027)		(0.034)		(0.034)		(0.043)	
Medium risk class	0.530***		0.539***		0.640***		0.655***	
	(0.070)		(0.085)		(0.090)		(0.111)	
Low risk class	1.426***		1.604***		1.663***		1.905***	
	(0.053)		(0.067)		(0.067)		(0.087)	
Observations	29,136	29,136	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

Table A.A18 – Table 2.7 Model (4) Estimated in Preference Space – Lowest Risk Class Interaction

	(1)		(2)		(3)		(4)	
VARIABLES	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations	Parameter means	Standard deviations
Management fees	-0.523***		-0.574***		-0.621***		-0.684***	
	(0.029)		(0.036)		(0.035)		(0.044)	
Gender interaction	0.243***		0.344***		0.219**		0.284**	
	(0.081)		(0.097)		(0.098)		(0.121)	
Age interaction	-0.001		-0.001		0.001		0.001	
	(0.005)		(0.006)		(0.006)		(0.008)	
Education interaction	0.130		0.098		0.028		0.012	
	(0.079)		(0.096)		(0.099)		(0.127)	
Income class interaction	0.006		0.007		-0.017		-0.013	
	(0.013)		(0.016)		(0.016)		(0.020)	
Risk index interaction	-0.191***		-0.256***		-0.167***		-0.223***	
	(0.035)		(0.044)		(0.043)		(0.055)	
Financial exp. interaction	-0.201**		-0.240**		-0.184*		-0.263**	
	(0.079)		(0.094)		(0.096)		(0.119)	
Gen. trust interaction	-0.083**		-0.116***		-0.109***		-0.157***	
	(0.034)		(0.043)		(0.041)		(0.052)	
Inst. trust interaction	0.008		0.010		0.027		0.018	
	(0.037)		(0.044)		(0.045)		(0.055)	
Patience interaction	0.103***		0.096**		0.070		0.039	
	(0.033)		(0.043)		(0.044)		(0.059)	
Altruism interaction	-0.001		-0.017		-0.000		-0.006	
	(0.030)		(0.037)		(0.036)		(0.047)	
Ecol. Politics interaction	-0.038		-0.033		-0.041		-0.026	
	(0.028)		(0.033)		(0.034)		(0.042)	
NEP interaction	0.050		0.057		0.022		0.006	
	(0.033)		(0.040)		(0.040)		(0.050)	
EU Ecolabel	0.893***	0.966***	1.001***	1.089***	0.886***	0.957***	1.015***	1.094***
	(0.049)	(0.045)	(0.061)	(0.056)	(0.060)	(0.054)	(0.076)	(0.069)
Medium green shares	-0.407***	1.297***	-0.417***	1.374***	-0.550***	1.424***	-0.577***	1.551***
	(0.078)	(0.069)	(0.094)	(0.084)	(0.099)	(0.086)	(0.119)	(0.108)
High green shares	0.146***	0.459***	0.161***	0.576***	0.130***	-0.378***	0.147***	0.519***
	(0.038)	(0.060)	(0.047)	(0.069)	(0.045)	(0.084)	(0.056)	(0.092)
Historical returns	0.168***		0.180***		0.192***		0.211***	
	(0.012)		(0.015)		(0.015)		(0.018)	
Medium risk class	0.553***		0.575***		0.673***		0.692***	
	(0.071)		(0.086)		(0.092)		(0.113)	
Low risk class	1.132***		1.309***		1.548***		1.824***	
	(0.167)		(0.203)		(0.211)		(0.269)	
Observations	29,136	29,136	22,122	22,122	20,832	20,832	15,801	15,801
'No Choice' included	YES	YES	NO	NO	YES	YES	NO	NO
'Rushers' included	YES	YES	YES	YES	NO	NO	NO	NO

A.B - Experimental Instructions and Survey

Page 1:

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Welcome to our survey about financial investments.

We would like to remind you that all data we collect in this survey will be used for non-commercial research purposes only and will be treated anonymously and confidentially.

Please always click on **"Next"** once you have answered all questions on a page. You are required to answer all questions before you are allowed to continue to the next page of the survey.

Thanks in advance for your participation!

Page 2:

7% completed

First off, please enter your 24 character Prolific ID.

Enter Prolific ID here

Page 3:

13% completed

Please read through the following text carefully and take your time in going through the instructions.

The following part of the survey takes the form of a so-called **choice experiment**. In this experiment, you will be asked to make hypothetical investment decisions. In each of these investment situations, you will be asked which out of three equity funds you would choose to invest **50€ per month over the next 10 years**, with the money to be used first after 10 years. **A fund is a pool of money that is professionally managed.** Retail investors can invest in funds with the goal to earn returns.

After answering each choice card, you will be able to additionally indicate if you would actually have preferred to invest in none of the funds. In total, you will be asked to respond to **eight of these choice situations**.

The funds differ with regards to five attributes - all fund characteristics not mentioned on the choice cards are precisely the same among the funds. You will find short explanations of the five choice attributes and their levels below the example choice card.

You can always recheck the information about the financial and sustainability attributes by clicking on the **info dialogue buttons** displayed on each page.

Example choice card:

	Fund 1	Fund 2	Fund 3
Annual fund management fees	2 %	1 %	0.01 %
Historical average annual returns (last 10 years)	16 %	7 %	7 %
Risk classification	7	6	5
EU Ecolabel	-	-	EU Ecolabel www.ecolabel.eu
Fund assets invested in green shares	at least 7.5 %	at least 10 %	at least 12.5 %

- **Annual fund management fees** are the yearly costs charged for the fund's management. Passively and actively managed funds have average annual fee levels of 0.2% and 1.2%, respectively.

- **Historical average annual returns (last 10 years)** are the historical average annual return calculated based on the fund performance in the past 10 years.

- **Risk classification** measures how much the fund's return varied historically, where a higher number indicates a higher risk. Risk categories 5, 6 & 7 have a historical volatility of 10%-15%, 15%-25% and >25% respectively.

- **The EU Ecolabel** is an EU-wide sustainability label. In general, an **Ecolabel** is a type of sustainability performance certification. In this case, it is based on the **EU taxonomy for sustainable activities**. The final report on the EU taxonomy can be found on the European Commission website. While the taxonomy group considers fund assets invested in green shares as one criterion for granting the EU Ecolabel, they also apply specific sustainability criteria (e.g. minimum social safeguards and screening criteria) to the remaining, non-green fund assets.

- **Fund assets invested in green shares** indicates the minimum percentage of the fund invested in green economic activities of the underlying company equities. Note that this attribute does not indicate anything about the sustainability of the non-green shares.

IMPORTANT: Experience from previous similar surveys is that people often respond in one way but would act differently in a real life situation. For example, it is common that people state a **higher willingness to pay** for a good or service than what they would actually be paying for it in reality. It is believed that this is due to the fact that people do not really consider how big an impact an extra cost actually has on their private budget and that it is easy to be generous when one does not really need to make actual choices in a store. To rule out such effects, we kindly ask you to answer the choice situations as truthfully and realistically as possible. In this specific case, this means you are asked to answer them as if you would consider investing with your own money.

After you have read the information carefully, we would like you to answer the following four questions. All information necessary to answer these questions correctly can be found on this page. Please make sure you are able to answer these questions correctly before progressing.

Between how many funds will you be able to choose in each of the eight choice situations?

- ◯ Two
- ◯ Three
- ◯ Four
- ◯ Five

- ◯ I don't know

By how many different attributes is each fund characterized?

- ◯ Two
- ◯ Three
- ◯ Four
- ◯ Five

- ◯ I don't know

What is the historical volatility of a fund that is classified to be in risk category 7?

- ◯ 10% - 15%
- ◯ 15% - 25%
- ◯ >25%
- ◯ around 5%

- ◯ I don't know

Which statement about the EU Ecolabel is correct?

Only one statement is correct.

- ◯ The EU Ecolabel is only supposed to be applicable in some EU countries.
- ◯ If a fund receives the EU Ecolabel, it means that every economic activity within this fund is 100% sustainable.
- ◯ The EU Ecolabel is a sustainability label based on the EU taxonomy for sustainable activities.
- ◯ Fund assets invested in green shares are the only criterion considered in granting the EU Ecolabel.

- ◯ I don't know

Page 4 (optional):

20% completed

This page appears because you have given the wrong answer to at least one of the questions on the last page or because you have clicked on "I don't know" as a response to at least one of them. We kindly ask you to take your time and go through the following information again carefully.

The following part of the survey takes the form of a so-called **choice experiment**. In this experiment, you will be asked to make hypothetical investment decisions. In each of these investment situations, you will be asked which out of three equity funds you would choose to invest **50€ per month over the next 10 years**, with the money to be used first after 10 years. **A fund is a pool of money that is professionally managed.** Retail investors can invest in funds with the goal to earn returns.

After answering each choice card, you will be able to additionally indicate if you would actually have preferred to invest in none of the funds. In total, you will be asked to respond to **eight of these choice situations**.

The funds differ with regards to five attributes - all fund characteristics not mentioned on the choice cards are precisely the same among the funds. You will find short explanations of the five choice attributes and their levels below the example choice card.

You can always recheck the information about the financial and sustainability attributes by clicking on the **info dialogue buttons** displayed on each page.

Example choice card:

	Fund 1	**Fund 2**	**Fund 3**
Annual fund management fees	2 %	1 %	0.01 %
Historical average annual returns (last 10 years)	16 %	7 %	7 %
Risk classification	7	6	5
EU Ecolabel	-	-	
Fund assets invested in green shares	at least 7.5 %	at least 10 %	at least 12.5 %

- **Annual fund management fees** are the yearly costs charged for the fund's management. Passively and actively managed funds have average annual fee levels of 0.2% and 1.2%, respectively.

- **Historical average annual returns (last 10 years)** are the historical average annual return calculated based on the fund performance in the past 10 years.

- **Risk classification** measures how much the fund's return varied historically, where a higher number indicates a higher risk. Risk categories 5, 6 & 7 have a historical volatility of 10%-15%, 15%-25% and >25% respectively.

- **The EU Ecolabel** is an EU-wide sustainability label. In general, an **Ecolabel** is a type of sustainability performance certification. In this case, it is based on the **EU taxonomy for sustainable activities**. The final report on the EU taxonomy can be found on the European Commission website. While the taxonomy group considers fund assets invested in green shares as one criterion for granting the EU Ecolabel, they also apply specific sustainability criteria (e.g. minimum social safeguards and screening criteria) to the remaining, non-green fund assets.

- **Fund assets invested in green shares** indicates the minimum percentage of the fund invested in green economic activities of the underlying company equities. Note that this attribute does not indicate anything about the sustainability of the non-green shares.

IMPORTANT: Experience from previous similar surveys is that people often respond in one way but would act differently in a real life situation. For example, it is common that people state a **higher willingness to pay** for a good or service than what they would actually be paying for it in reality. It is believed that this is due to the fact that people do not really consider how big an impact an extra cost actually has on their private budget and that it is easy to be generous when one does not really need to make actual choices in a store. To rule out such effects, we kindly ask you to answer the choice situations as truthfully and realistically as possible. In this specific case, this means you are asked to answer them as if you would consider investing with your own money.

Page 5-12 (random draw between 36 choice cards design within each treatment group):

27% completed

Choice Experiment

Please choose according to your personal preference.

If you would like to take another look at the information on the financial characteristics of a given investment product or the sustainability labels, please click on the respective box below.

Finance attribute info | Label attribute info

	Fund 1	**Fund 2**	**Fund 3**
Annual fund management fees	2 %	1 %	0.01 %
Historical average annual returns (last 10 years)	16 %	7 %	7 %
Risk classification	7	6	5
EU Ecolabel	-	-	EU Ecolabel www.ecolabel.eu
Fund assets invested in green shares	at least 7.5 %	at least 10 %	at least 12.5 %

Which of the investment products above would you choose?

○ Fund 1 ○ Fund 2 ○ Fund 3

Would you have preferred to choose none of the investment products above if that would have been an option?

○ Yes ○ No ○ I don't know / I don't want to answer

Page 13:

63% completed

Attitudinal Questionnaire

Now, we would like to ask you to state your level of agreement to a number of statements relating to different topics such as, e.g., financial investments or your political orientation.

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation.

Provide a rating from "Extremely Unlikely" to "Extremely Likely", using the following scale:

	Extremely Unlikely	Moderately Unlikely	Somewhat Unlikely	Not Sure	Somewhat Likely	Moderately Likely	Extremely Likely	I don't want to answer
Investing 10% of your annual income in a moderate growth diversified fund.	○	○	○	○	○	○	○	○
Betting a day's income on the outcome of a sporting event.	○	○	○	○	○	○	○	○
Investing 10% of your annual income in a new business venture.	○	○	○	○	○	○	○	○

Which of the following statements is correct?

- ○ Once one invests in a mutual fund, one cannot withdraw the money in the first year
- ○ Mutual funds can invest in several assets, for example, invest in both stocks and bonds
- ○ Mutual funds pay a guaranteed rate of return which depends on their past performance
- ○ None of the above
- ○ I don't know

○ I don't want to answer this question

If the interest rate falls, what should happen to bond prices?

- They should rise
- They should fall
- They should stay the same
- None of the above
- I don't know

- I don't want to answer this question

When an investor spreads his money among different assets, does the risk of losing money increase, decrease or stay the same?

- It increases
- It decreases
- It stays the same
- I don't know

- I don't want to answer this question

How many years of experiences do you have investing your personal money?

E.g., investment in stocks, mutual funds or ETFs. Putting money in a savings account to earn interest rates does not count as investment here.

- None
- 0-3 years
- 3-5 years
- 5-10 years
- more than 10 years
- I don't know

- I don't want to answer this question

Please indicate to what extent you agree with the following statements.

Do so by choosing from a scale ranging from "Totally Disagree" to "Totally Agree".

	Totally Disagree	Rather Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Rather Agree	Totally Agree	I don't want to answer
I am convinced that most people have good intentions.								
You cannot rely on anyone else these days.								
In general, people can be trusted.								

Please indicate to what extent you agree with the following statements.

Do so by choosing from a scale ranging from "Totally Disagree" to "Totally Agree".

	Totally Disagree	Rather Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Rather Agree	Totally Agree	I don't want to answer
I feel secure that institutional agencies in the EU adequately protect me.								
I feel confident that regulatory agencies and other institutions in the EU make it safe for me to invest in sustainable funds.								
I feel assured that EU institutions do a good job making laws that protect people.								
The EU is an independent institution that is not influenced by lobbyism.								

For each of the following statements, please indicate your willingness that you would engage in the described activity or behavior.

Provide a rating from "Extremely Unwilling" to "Extremely Willing", using the following scale:

	Extremely Unwilling	Moderately Unwilling	Somewhat Unwilling	Not Sure	Somewhat Willing	Moderately Willing	Extremely Willing	I don't want to answer
How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?								
How willing are you to give to good causes without expecting anything in return?								

Please indicate to what extent you agree with the following statements regarding your personal political views.

Do so by choosing from a scale ranging from "Totally Disagree" to "Totally Agree".

	Totally Disagree	Rather Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Rather Agree	Totally Agree	I don't want to answer
I identify myself with conservatively oriented politics.								
I identify myself with liberally oriented politics.								
I identify myself with socially oriented politics.								
I identify myself with ecologically oriented politics.								

Please indicate to what extent you agree with the following statements on the environment.

Do so by choosing from a scale ranging from "Totally Disagree" to "Totally Agree".

	Totally Disagree	Rather Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Rather Agree	Totally Agree	I don't want to answer
Humans have the right to modify the natural environment to suit their needs.								
Human ingenuity will ensure that we do not make the planet uninhabitable.								

Page 14:

75% completed

Sociodemographic Questionnaire

To conclude the survey, we would like to gather some socioeconomic information about yourself.

What is your gender?

- Female
- Male
- Divers/Other
  You may specify here

- I don't want to answer this question

How old are you?

Please answer in years.

Please enter your age (in years) here | I don't want to answer this question

What is your highest school leaving certificate and what academic education and/or professional training have you completed?

For academic education and professional training, please also indicate the subject area (e.g., academic degree: economics, professional training: bank clerk). Multiple answers are possible.

- ☐ No school leaving certificate
- ☐ Secondary school leaving certificate
- ☐ High school diploma (higher education entrance qualification)
- ☐ Professional training (e.g. electronics technician, accountant, etc.)
  You may specify here
- ☐ University degree (Diploma, Bachelor's, Master's)
  You may specify here
- ☐ PhD
  You may specify here
- ☐ Other
  You may specify here

- ☐ I don't want to answer this question

Please indicate the monthly net household income of all persons currently living permanently in your household?

Please indicate your current monthly net amount, i.e., after deduction of taxes and social security contributions and add regular payments such as pensions, unemployment benefit, housing benefit, etc. If you are not sure, you might also estimate the monthly amount.

- ○ Less than 500€
- ○ 500€ to less than 1000€
- ○ 1000€ to less than 1500€
- ○ 1500€ to less than 2000€
- ○ 2000€ to less than 2500€
- ○ 2500€ to less than 3000€
- ○ 3000€ to less than 3500€
- ○ 3500€ to less than 4000€
- ○ 4000€ to less than 4500€
- ○ 4500€ to less than 5000€
- ○ 5000€ or more
- ○ I don't know

- ○ I don't want to answer this question

How many people (including yourself) currently live in your household?

This should include people of all ages (including children).

Please enter the total amount of people here ☐ I don't want to answer this question

Page 15:

88% completed

If you have any feedback on this survey that you would like to provide us with, you might enter your comments below.

Enter your comments here

Page 16:

Thank you for completing this questionnaire!

We would like to thank you very much for helping us.

Please follow the link below (completion URL) to confirm your participation with Prolific.

https://app.prolific.co/submissions/complete?cc=48A7D1F5

Your answers were transmitted, you may close the browser window or tab now.

A.C - Additional Example Choice Cards

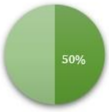
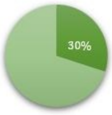
Group T1:

	Fund 1	Fund 2	Fund 3
Annual fund management fees	1.5 %	1.5 %	0.01 %
Historical average annual returns (last 10 years)	10 %	13 %	10 %
Risk classification	6	5	7
EU Ecolabel	-	-	EU Ecolabel www.ecolabel.eu Better for the environment... • Investing in activities that contribute to a green and low carbon economy • Avoiding investment in environmentally and socially harmful activities • Engaging with companies to become more environmentally sustainable ... better for you
Fund assets invested in green shares	at least 10 %	at least 7.5 %	at least 12.5 %

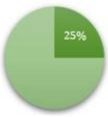
Group T2:

	Fund 1	Fund 2	Fund 3
Annual fund management fees	1 %	2 %	0.01 %
Historical average annual returns (last 10 years)	4 %	16 %	10 %
Risk classification	6	5	7
EU Ecolabel	EU Ecolabel www.ecolabel.eu Better for the environment... • Investing in activities that contribute to a green and low carbon economy • Avoiding investment in environmentally and socially harmful activities • Engaging with companies to become more environmentally sustainable ... better for you The product fulfills criteria consistent with the Taxonomy Regulation (EU) 2020/852	-	EU Ecolabel www.ecolabel.eu Better for the environment... • Investing in activities that contribute to a green and low carbon economy • Avoiding investment in environmentally and socially harmful activities • Engaging with companies to become more environmentally sustainable ... better for you The product fulfills criteria consistent with the Taxonomy Regulation (EU) 2020/852
Fund assets invested in green shares	at least 10 %	at least 7.5 %	at least 12.5 %

Group T3:

	Fund 1	Fund 2	Fund 3
Annual fund management fees	0.01 %	2 %	1 %
Historical average annual returns (last 10 years)	16 %	16 %	13 %
Risk classification	7	5	6
EU Ecolabel	-	EU Ecolabel www.ecolabel.eu Better for the environment... • Investing in activities that contribute to a green and low carbon economy • Avoiding investment in environmentally and socially harmful activities • Engaging with companies to become more environmentally sustainable ... better for you The product fulfills criteria consistent with the Taxonomy Regulation (EU) 2020/852	-
Fund assets invested in green shares	 Share of fund assets invested in companies with at least 25% green turnover	 Share of fund assets invested in companies with at least 25% green turnover	 Share of fund assets invested in companies with at least 25% green turnover

Group T4:

	Fund 1	Fund 2	Fund 3
Annual fund management fees	1 %	0.5 %	1.5 %
Historical average annual returns (last 10 years)	4 %	4 %	7 %
Risk classification	6	6	5
EU Ecolabel	-	-	EU Ecolabel www.ecolabel.eu Better for the environment... • Investing in activities that contribute to a green and low carbon economy • Avoiding investment in environmentally and socially harmful activities • Engaging with companies to become more environmentally sustainable ... better for you The product fulfills criteria consistent with the Taxonomy Regulation (EU) 2020/852
Fund assets invested in green shares	 Share of fund assets invested in companies with at least 50% green turnover	 Share of fund assets invested in companies with at least 50% green turnover	 Share of fund assets invested in companies with at least 50% green turnover

Appendix B (Chapter 3)

B.A – Additional Tables

Table B.A1 – Variable Definitions and Descriptive Statistics (Full Experimental Sample - n=192)

	definition	n	mean	sd	min	max
male	=1 if tailor is male	192	0.792	0.407	0	1
age	tailor’s age	189	34.09	7.924	21	59
uneducated	=1 if no formal education	189	0.169	0.376	0	1
prim. education started	=1 if primary education started	189	0.439	0.498	0	1
prim. education completed	=1 if primary education completed	189	0.312	0.465	0	1
muslim	=1 if tailor is muslim	192	0.526	0.501	0	1
mossi	=1 if tailor is mossi	189	0.746	0.436	0	1
born in ouaga	=1 if tailor was born in ouagadougou	192	0.307	0.463	0	1
bank account	=1 if tailor uses bank account to deposit earnings	192	0.479	0.501	0	1
risk attitude	self-assessed risk-scale from 1 (low risk) to 4 (high risk)	189	2.238	1.032	1	4
household members	# permanent members in tailor’s household	189	4.778	2.720	1	15
siblings	# tailor’s siblings	188	4.824	2.416	0	13
household members not working	# unemployed people in tailor’s household	192	2.401	2.062	0	10
family help received	=1 if tailor received financial support from family in start-up phase	192	0.193	0.395	0	1
family tradition	=1 if tailor’s family has owned a tailor shop already	192	0.135	0.343	0	1
positive net family transfers	family financial transfers received minus transfers made > 0	192	0.792	0.407	0	1
business founder	=1 if tailor founded the business	192	0.958	0.200	0	1
enterprise age	# years the business has been running	189	7.148	6.237	1	31

total staff	# workers supporting the tailor on permanent basis	189	3.995	1.629	2	11
paid staff	# paid workers supporting the tailor on permanent basis	189	0.772	1.197	0	5
working hours	average hours tailor works for the business per month	192	259.4	71.83	0	420
weekly average profit	average weekly profit (in 1000 FCA)	192	14.08	40.27	0	540

Table B.A1a – Probit Regression on Sampling Between Stages II & III

VARIABLES	(1) DV: *member of Stage III* *Full survey sample*	(2) DV: *member of Stage III* *Full survey sample*	(3) DV: *member of Stage III* *Only no contact*	(4) DV: *member of Stage III* *Only no contact*
male	0.0277	0.399*	0.0605	0.406*
	(0.165)	(0.204)	(0.179)	(0.220)
age		-0.0208*		-0.0205*
		(0.0113)		(0.0124)
uneducated		-0.0509		0.0670
		(0.316)		(0.336)
prim. education started		0.227		0.269
		(0.290)		(0.303)
prim. education completed		0.432		0.410
		(0.302)		(0.318)
muslim		-0.133		-0.153
		(0.153)		(0.161)
mossi		0.404**		0.381**
		(0.167)		(0.176)
born in ouaga	-0.292**	-0.415***	-0.166	-0.336*
	(0.142)	(0.161)	(0.155)	(0.175)
bank account	0.665***	0.693***	0.592***	0.627***
	(0.145)	(0.161)	(0.155)	(0.173)
risk attitude		-0.106		-0.132
		(0.0783)		(0.0825)
household members		0.140**		0.164**
		(0.0585)		(0.0644)
siblings		-0.0263		-0.0219
		(0.0308)		(0.0336)
household members not working		-0.137*		-0.158**
		(0.0736)		(0.0794)
family help received	0.106	0.227	-0.0877	-0.0109
	(0.168)	(0.183)	(0.180)	(0.195)
family tradition	0.130	0.167	0.0507	0.0410
	(0.202)	(0.216)	(0.217)	(0.231)
positive net family transfers	0.866***	1.064***	0.416**	0.552***
	(0.148)	(0.166)	(0.176)	(0.196)
business founder	-0.399	0.218	-	-
	(0.339)	(0.430)		
enterprise age		0.0111		-3.27e-05
		(0.0147)		(0.0166)
total staff		0.152***		0.172***
		(0.0493)		(0.0560)
paid staff		-0.266***		-0.253***
		(0.0643)		(0.0690)
working hours	0.000328	0.00175	0.000450	0.000866
	(0.00101)	(0.00115)	(0.00114)	(0.00125)
weekly average profit	0.000172	-0.000376	0.000287	-0.000324
	(0.00253)	(0.00277)	(0.00259)	(0.00283)
constant	-0.486	-1.918***	-0.463	-0.968
	(0.395)	(0.735)	(0.371)	(0.736)
Observations	386	376	321	315

*Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 – Probit regressions with robust standard errors and dependent variable: Member of sampling Stage III (dummy) - Specification in column (1) only includes the control variables used in the analysis (only includes variables that allow us to maintain our full set of observations). Specification in column (2) includes all socioeconomic control variables that we also show in the remainder of our descriptive analysis.*

Table B.A1b – Sampling Balance Test (Full Experimental Sample - n=192)

	Control			Treatment			t-test	norm
	n	mean	sd	n	mean	sd	diff	diff
male	96	0.80	0.40	96	0.78	0.42	-0.021	-0.051
age	95	33.59	8.31	94	34.60	7.53	1.006	0.127
uneducated	95	0.23	0.42	94	0.11	0.31	-0.125**	-0.333
prim. education started	95	0.35	0.48	94	0.53	0.50	0.185**	0.371
prim. education completed	95	0.34	0.48	94	0.29	0.45	-0.050	-0.107
muslim	96	0.55	0.50	96	0.50	0.50	-0.052	-0.104
mossi	95	0.76	0.43	94	0.73	0.44	-0.024	-0.055
born in ouaga	96	0.30	0.46	96	0.31	0.47	0.010	0.023
bank account	96	0.46	0.50	96	0.50	0.50	0.042	0.083
risk attitude	95	2.24	1.06	94	2.23	1.01	-0.008	-0.008
household members	95	4.80	2.80	94	4.76	2.65	-0.045	-0.016
siblings	94	4.64	2.35	94	5.01	2.48	0.372	0.154
household members not working	96	2.36	2.08	96	2.44	2.05	0.073	0.035
family help received	96	0.23	0.42	96	0.16	0.36	-0.073	-0.184
family tradition	96	0.17	0.37	96	0.10	0.31	-0.062	-0.182
positive net family transfers	96	0.76	0.43	96	0.82	0.38	0.063	0.052
business founder	96	0.96	0.20	96	0.96	0.20	0.000	0.153
enterprise age	95	6.87	6.41	94	7.43	6.08	0.552	0.088
total staff	95	3.85	1.63	94	4.14	1.62	0.286	0.175
paid staff	95	0.71	1.16	94	0.84	1.24	0.135	0.113
working hours	96	260.68	74.51	96	258.17	69.40	-2.510	-0.035
weekly average profit	96	12.33	16.29	96	15.83	54.67	3.495	0.087

Test for equality of two group means, assuming homogeneity:

	Statistic	F(df1,	df2)	=F	Prob>F
Wilks' lambda	0.8152	25.0	95.0	0.86	0.6544e
Pillai's trace	0.1848	25.0	95.0	0.86	0.6544e
Lawley-Hotelling trace	0.2268	25.0	95.0	0.86	0.6544e
Roy's largest root	0.2268	25.0	95.0	0.86	0.6544e

e = exact

Table B.A1c – Calculation of Minimum Detectable Effect Sizes

		medium power (50%)	high power (80%)
1.	Main Treatment Effect (Table 1 column 1)	Delta=0.830*1.96= 1.627 Cohen's d= 0.350	Delta=0.830*2.80= 2.324 Cohen's d= 0.500
2.	Interaction term between treatment and past family help (Table 1 column 4)	Delta=1.633*1.96= 3.201 Cohen's d= 0.689	Delta=1.633*2.80= 4.572 Cohen's d= 0.984
3.	Interaction term between treatment and net positive transfers (Table 1 column 5)	Delta=1.862*1.96= 3.650 Cohen's d= 0.786	Delta=1.862*2.80= 5.214 Cohen's d= 1.230
4.	Interaction term between treatment and family tradition in tailoring (Table 1 column 6)	Delta=1.638*1.96= 3.210 Cohen's d= 0.691	Delta=1.638*2.80= 4.586 Cohen's d= 0.988
5.	Interaction term between treatment and use of bank account (Table 1 column 7)	Delta=1.631*1.96= 3.197 Cohen's d= 0.688	Delta=1.631*2.80= 4.567 Cohen's d= 0.983

Note: Minimum detectable effect sizes calculated according to (Ioannidis et al., 2017). *Respective MDEs are calculated on basis of the observed coefficient standard errors. Cohen's d was calculated by dividing respective MDE by the pooled standard deviation of the number of produced bags (SD = 4.644).*

Table B.A2 – Variable Definitions and Descriptive Statistics (Final Sample / Accepted Offer – n = 125)

	definition	n	mean	sd	min	max
bags	# bags produced	125	5.728	4.644	0	20
male	=1 if tailor is male	125	0.776	0.419	0	1
age	tailor's age	122	34.23	8.116	21	59
uneducated	=1 if no formal education	122	0.172	0.379	0	1
prim. education started	=1 if primary education started	122	0.451	0.500	0	1
prim. education completed	=1 if primary education completed	122	0.311	0.465	0	1
muslim	=1 if tailor is muslim	125	0.496	0.502	0	1
mossi	=1 if tailor is mossi	122	0.787	0.411	0	1
born in ouaga	=1 if tailor was born in ouagadougou	125	0.296	0.458	0	1
bank account	=1 if tailor uses bank account to deposit earnings	125	0.472	0.501	0	1
risk attitude	self-assessed risk-scale from 1 (low risk) to 4 (high risk)	122	2.279	1.031	1	4
household members	# permanent members in tailor's household	122	4.795	2.739	1	15
siblings	# tailor's siblings	122	4.705	2.442	0	13
household members not working	# unemployed people in tailor's household	125	2.384	2.113	0	10
family help received	=1 if tailor received financial support from family in start-up phase	125	0.200	0.402	0	1
family tradition	=1 if tailor's family has owned a tailor shop already	125	0.120	0.326	0	1
positive net family transfers	family financial transfers received minus transfers made > 0	125	0.808	0.395	0	1
business founder	=1 if tailor founded the business	125	0.960	0.197	0	1
enterprise age	# years the business has been running	122	6.959	5.840	1	28
total staff	# workers supporting the tailor on permanent basis	122	4.107	1.670	2	11
paid staff	# paid workers supporting the tailor on permanent basis	122	0.828	1.238	0	5
working hours	average hours tailor works for the business per month	125	257.7	76.50	0	420
weekly average profit	average weekly profit (in 1000 FCA)	125	15.51	48.38	0	540

Table B.A2a – Sampling Balance Test (Final Sample / Accepted Offer - n=125)

	Control			Treatment			t-test	norm
	n	mean	sd	n	mean	sd	diff	Diff
male	68	0.79	0.41	57	0.75	0.43	-0.040	-0.095
age	67	34.34	8.69	55	34.09	7.43	-0.252	-0.031
uneducated	67	0.22	0.42	55	0.11	0.31	-0.115*	-0.303
prim. education started	67	0.39	0.49	55	0.53	0.50	0.139	0.279
prim. education completed	67	0.31	0.47	55	0.31	0.47	-0.004	-0.009
muslim	68	0.49	0.50	57	0.51	0.50	0.023	0.047
mossi	67	0.79	0.41	55	0.78	0.42	-0.009	-0.022
born in ouaga	68	0.29	0.46	57	0.30	0.46	0.004	0.009
bank account	68	0.49	0.50	57	0.46	0.50	-0.029	-0.058
risk attitude	67	2.24	1.07	55	2.33	0.98	0.088	0.086
household members	67	5.01	2.87	55	4.53	2.57	-0.488	-0.178
siblings	67	4.67	2.39	55	4.75	2.53	0.074	0.030
household members not working	68	2.54	2.19	57	2.19	2.02	-0.351	-0.166
family help received	68	0.22	0.42	57	0.18	0.38	-0.045	-0.112
family tradition	68	0.18	0.38	57	0.05	0.23	-0.124**	-0.380
positive net family transfers	68	0.78	0.05	57	0.84	0.05	-0.063	-0.104
business founder	68	0.97	0.17	57	0.95	0.23	-0.023	-0.118
enterprise age	67	6.94	6.27	55	6.98	5.33	0.042	0.007
total staff	67	4.06	1.77	55	4.16	1.56	0.104	0.062
paid staff	67	0.78	1.28	55	0.89	1.20	0.115	0.093
working hours	68	257.10	76.85	57	258.42	76.75	1.318	0.017
weekly average profit	68	11.96	11.40	57	19.75	70.67	7.799	0.161

Test for equality of two group means, assuming homogeneity:

	Statistic	F (df1,	df2)	=F	Prob>F
Wilks' lambda	0.8209	24.0	96.0	0.87	0.6364 e
Pillai's trace	0.1791	24.0	96.0	0.87	0.6364 e
Lawley-Hotelling trace	0.2182	24.0	96.0	0.87	0.6364 e
Roy's largest root	0.2182	24.0	96.0	0.87	0.6364 e

e = exact

Table B.A2b – Check for Selective Attrition Between Sampling Stages III & IV

VARIABLES	(1) DV: *member of final sample*	(2) *DV: member of final sample*
male	-0.174	-0.133
	(0.242)	(0.283)
age		0.0163
		(0.0175)
uneducated		0.485
		(0.411)
prim. education started		0.441
		(0.363)
prim. Education completed		0.570
		(0.387)
muslim		-0.0969
		(0.209)
mossi		0.478**
		(0.240)
born in ouaga	-0.0895	-0.139
	(0.204)	(0.227)
bank account	-0.0533	-0.0746
	(0.199)	(0.215)
risk attitude		0.121
		(0.101)
hh members		-0.00947
		(0.0746)
siblings		-0.0522
		(0.0432)
household members not working		0.00116
		(0.0988)
family help received	0.100	0.205
	(0.251)	(0.260)
family tradition	-0.141	0.0123
	(0.282)	(0.302)
positive net family transfers	0.192	0.351
	(0.245)	(0.263)
business founder	0.0995	0.701
	(0.474)	(0.563)
enterprise age		-0.0170
		(0.0207)
total staff		0.117
		(0.0714)
paid staff		0.0271
		(0.0955)
working hours	-0.000494	0.000762
	(0.00142)	(0.00164)
weekly average profit	0.00283	0.00283
	(0.00307)	(0.00335)
constant	0.427	-2.313**
	(0.500)	(1.074)
Observations	192	188

*Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Probit regressions with robust standard errors and dependent variable: Member of the final experimental sample (dummy) - Specification in column (1) only includes the control variables used in the analysis (which only includes variables that allow us to maintain our full set of observations). Specification in column (2) includes all socioeconomic control variables that we also show in the remainder of our descriptive analysis.*

Table B.A3 – Summary Statistics on Variables from Follow-up Survey

VARIABLE	definition	Control			Treatment			diff
		n	mean	sd	n	mean	sd	
people helping with task	# of people helping with the bag production	67	1.37	0.74	57	1.72	0.96	0.346**
other priorities	= 1 if respondent stated that he was busy with other commitments	67	0.16	0.37	57	0.18	0.38	0.011
worked all night	= 1 if respondent stated that he worked all night on the bag production	67	0.22	0.42	57	0.11	0.31	-0.119*
reported having problems	= 1 if respondent reported having problems with the bag production	67	0.39	0.49	57	0.39	0.49	-0.002
problems with family	= 1 if respondent reported having problems with the bag production due to family issues (e.g. health issues of relatives)	67	0.06	0.24	57	0.05	0.23	-0.007
problems with electricity	= 1 if respondent reported having problems with the bag production due to electricity issues (e.g. electricity cuts)	67	0.19	0.40	57	0.28	0.45	0.087
problems with sewing machine	= 1 if respondent reported having problems with the bag production due to issues with the sewing machine	67	0.15	0.36	57	0.09	0.29	-0.062

Table B.A3a – Probit Regressions on Problems Reported

VARIABLES	(1) DV: *reported problems*	(2) DV: *reported problems*
treatment	-0.00547	-0.0494
	(0.230)	(0.247)
male		0.227
		(0.285)
born in ouaga		-0.318
		(0.267)
family help received		0.319
		(0.308)
positive net family transfers		0.0481
		(0.320)
bank account		-0.500**
		(0.250)
family tradition		-0.358
		(0.398)
business founder		-0.185
		(0.623)
working hours		-0.000295
		(0.00173)
weekly average profit		-0.00696
		(0.0116)
constant	-0.284*	0.149
	(0.156)	(0.635)
Observations	124	124

*Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Probit regressions with robust standard errors and dependent variable: Problems reported (dummy)*

Table B.A3b – Zero Bag Producers

VARIABLES	(1) DV: *zerobags*	(2) DV: *zerobags*
treatment	-0.105	-0.206
	(0.272)	(0.293)
problems with electricity	-1.151**	-1.244**
	(0.509)	(0.569)
problems with sewing machine	1.118***	1.424***
	(0.380)	(0.459)
problems with family	-0.190	0.287
	(0.618)	(0.738)
other priorities	0.563*	0.506
	(0.336)	(0.378)
family help received		-0.185
		(0.383)
positive net family transfers		0.921**
		(0.412)
bank account		0.274
		(0.308)
family tradition		0.272
		(0.500)
business founder		-1.372*
		(0.738)
working hours		-0.00129
		(0.00166)
weekly average profit		0.00411**
		(0.00161)
male		0.0438
		(0.391)
born in ouaga		0.838**
		(0.330)
constant	-0.762***	-0.470
	(0.216)	(0.690)
Observations	124	124

*Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Probit regressions with robust standard errors and dependent variable: Zero bags produced (dummy)*

Table B.A4 – Main Regression Model (with additional controls)

VARIABLES	(1) Main effect	(2) Main effect	(3) Interaction *siblings*	(4) Interaction *help*	(5) Interaction *transfer*	(6) Interaction *family staff*	(7) Interaction *tradition*	(8) Interaction *bank*
treatment (network informed)	0.477	0.0837	1.773	0.712	-0.565	0.930	-0.0993	2.907***
	(0.876)	(2.280)	(1.704)	(1.070)	(0.983)	(1.643)	(0.913)	(1.021)
treatment x no. of siblings			-0.251					
			(0.309)					
treatment x family help		4.996***		5.352***				
		(1.734)		(1.678)				
treatment x positive transfers		1.083			-0.559			
		(2.105)			(1.938)			
treatment x family staff		0.143				-0.288		
		(0.822)				(0.913)		
treatment x family tradition		8.970***					7.070***	
		(2.340)					(1.758)	
treatment x bank account		-4.850***						-5.113***
		(1.584)						(1.609)
no. of siblings			0.0272					
			(0.209)					
family help received	1.607	0.0293	1.653	1.607	-0.682	1.620	1.712	2.082**
	(1.002)	(1.410)	(1.032)	(1.011)	(1.294)	(1.014)	(1.040)	(0.998)
positive net family transfers	-1.240	-0.956	-1.035	-1.237	-1.405	-1.021	-0.792	-0.929
	(0.958)	(1.346)	(1.007)	(0.968)	(1.002)	(1.257)	(0.951)	(0.998)
family members in staff	-0.156	-0.299	-0.166	-0.0373	-0.138	-0.155	-0.217	-0.179
	(0.474)	(0.578)	(0.476)	(0.621)	(0.453)	(0.475)	(0.473)	(0.423)
family tradition	-0.258	-1.932	-0.272	-0.235	-0.253	-0.293	-1.765	-0.0705
	(1.230)	(1.344)	(1.227)	(1.246)	(1.322)	(1.246)	(1.235)	(1.320)
bank account	0.00576	1.944	0.0268	-3.23e-05	-0.266	0.0218	-0.0483	2.418*
	(0.848)	(1.248)	(0.872)	(0.852)	(0.840)	(0.855)	(0.835)	(1.236)
control group mean	5.574***	5.574***	5.574***	5.574***	5.574***	5.574***	5.574***	5.574***
Observations	125	125	122	125	125	125	125	125
R-squared	0.039	0.205	0.047	0.040	0.090	0.040	0.079	0.112

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Dependent variable: Bags produced - OLS regressions with robust standard errors.*

Table B.A4a – Main Regression Model (Cragg hurdle regressions)

VARIABLES	(1) hurdle bags > 0	(2) hurdle bags	(3) hurdle bags > 0	(4) hurdle bags
treatment	-0.292	0.220	-0.202	0.284
	(0.921)	(0.247)	(0.922)	(0.261)
family help received			1.644	0.279
			(1.118)	(0.356)
positive net family transfers			-0.183	-0.532
			(1.117)	(0.371)
bank account			0.789	-0.194
			(0.934)	(0.258)
family tradition			-0.198	-0.0440
			(1.439)	(0.397)
family staff			0.330	-0.126
			(0.465)	(0.121)
Constant	7.407***	0.585***	6.587***	1.165***
	(0.654)	(0.162)	(1.323)	(0.409)
Observations	125	125	125	125
Controls	NO	NO	YES	YES

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Cragg hurdle regressions with dependent variable: Bags produced.*

Table B.A4b – Main Regression Model (Tobit regressions)

VARIABLES	(1) tobit	(2) tobit	(3) tobit	(4) tobit	(5) tobit	(6) tobit	(7) tobit	(8) tobit
treatment	0.825	1.049	3.424	-0.498	1.244	1.406	0.127	4.300***
	(1.232)	(1.234)	(2.663)	(1.333)	(2.783)	(1.573)	(1.252)	(1.626)
no. of siblings			0.195					
			(0.345)					
treatment x no. of siblings			-0.464					
			(0.506)					
treatment x family help				7.777**				
				(3.008)				
treatment x positive transfers					-0.242			
					(3.101)			
treatment x family staff						-0.451		
						(1.231)		
treatment x family tradition							12.56**	
							(5.091)	
treatment x bank account								-7.005***
								(2.371)
family help received		2.136	2.124	-1.200	2.141	2.137	2.302	2.820*
		(1.554)	(1.572)	(1.983)	(1.555)	(1.553)	(1.513)	(1.512)
positive net family transfers		-1.841	-1.707	-2.056	-1.746	-1.841	-1.056	-1.448
		(1.550)	(1.687)	(1.506)	(1.973)	(1.549)	(1.545)	(1.489)
family staff		-0.182	-0.254	-0.168	-0.182	0.000817	-0.335	-0.216
		(0.620)	(0.625)	(0.603)	(0.620)	(0.795)	(0.608)	(0.598)
family tradition		-0.0707	-0.197	-0.0472	-0.0860	-0.0198	-2.485	0.130
		(1.910)	(1.917)	(1.845)	(1.920)	(1.914)	(2.103)	(1.828)
bank account		-0.213	-0.292	-0.649	-0.207	-0.225	-0.225	3.106*
		(1.231)	(1.251)	(1.208)	(1.234)	(1.231)	(1.202)	(1.629)
Constant	4.724***	5.923***	4.952*	7.068***	5.848***	5.788***	5.845***	3.878**
	(0.840)	(1.777)	(2.555)	(1.777)	(2.017)	(1.814)	(1.737)	(1.844)
Observations	125	125	122	125	125		125	125
Controls	NO	YES	YES	YES	YES		YES	YES

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 - Dependent variable: Bags produced – Tobit regressions censored at 0 and 12 bags.*

B.B – Photos of the Bag Production

B.B1 - Examples of bag materials during the pre-test phase. Bags were supposed to be produced with recycled materials.

B.B2 – A tailor with one of our sample bags and a more traditional type of sewing machine in the foreground.

Appendix C (Chapter 4)

C.A – Literature Review: Socioeconomic Impact of Rural Electrification Initiatives

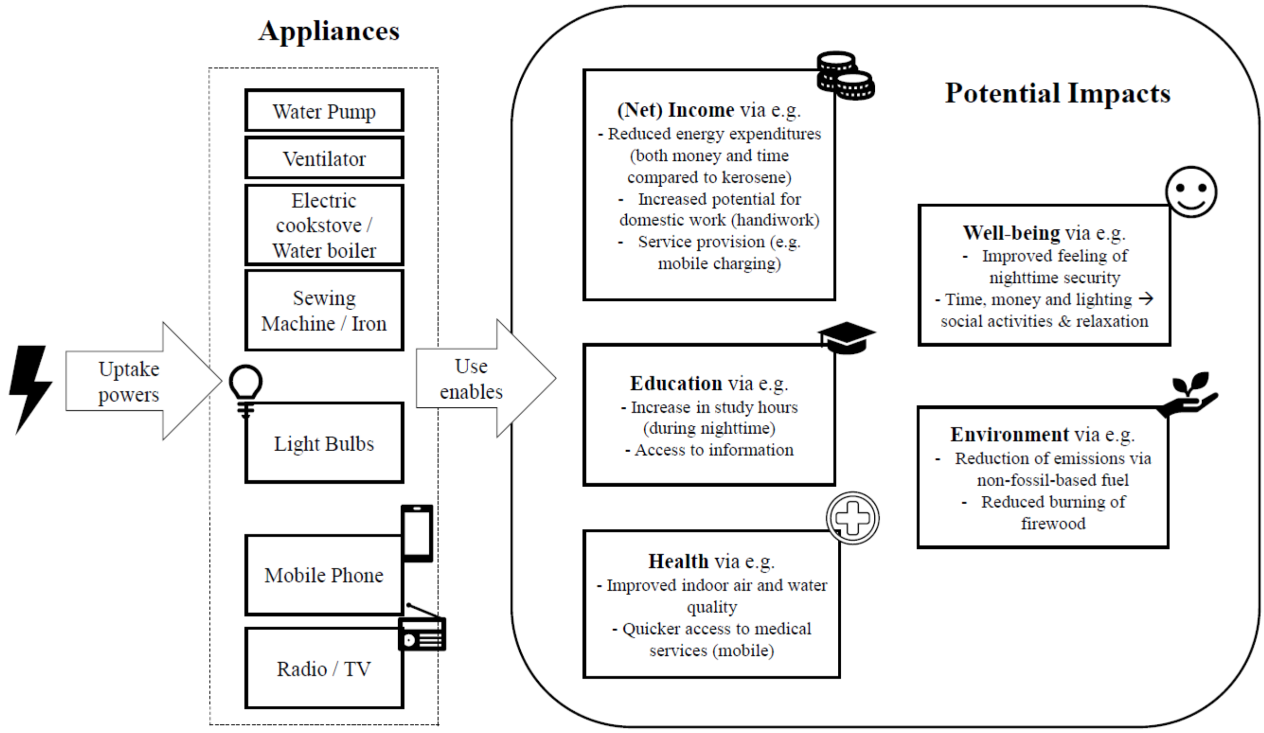
C.A.A. Electrification and Economic Development

The international community as represented by the UN regards universal access to electricity as one of the core pathways to global sustainable welfare. This was formally manifested as part of the UN's 2030 agenda for sustainable development, where universal electricity access was defined as SDG #7 (UNGA, 2015). In line with economic theory on the relationship between energy input and economic development, different macroeconomic correlation studies present evidence of the positive linkage between electricity access and socioeconomic development across the globe (Ferguson et al., 2000; Stern et al., 2019). More in-depth analyses on this relationship, providing disaggregated analysis with regards to the dimensions of the Human Development Index (HDI) (i.e., national income, literacy rate, schooling years, and life expectancy at birth) show that electricity consumption and the different HDI dimensions causally influence each other in the long run with variation in trends across low-, middle- and high-income countries (Huang et al., 2008; Niu et al., 2013). The general trend describing these variations seems to be that the correlation between electricity use and wealth creation appears to be larger in high-income countries (Ferguson et al., 2000).

C.A.B. Rural Electrification - Theory and premise

A specific strand of microeconomic literature is concerned with the specific efficacies of electrification in the context of rural development, especially in low-income countries. Early research on this matter goes back as far as the 1980s (Barnes, 2014), but has picked up since the late early to mid-2000s (Bhattacharyya, 2006; Kanagawa & Nakata, 2008; Wamukonya & Davis, 2001), when researchers started to apply more rigorous statistical methodology to identify causal effects of electricity access on different socioeconomic indicators. An often-cited contribution from these early days is Cook (2011), who provided a comprehensive review of the role of electrification in the context of rural development, as well as the underlying social and economic issues related to this matter. The author postulates that, from a theoretical perspective, electricity provision can be regarded as an infrastructure investment that increases input productivity and encourages private investments. Especially in rural contexts, electrification can promote firm migration into recently electrified areas to exploit potential geographical advantages. Cook (2011) further emphasizes that the potential positive effects of electricity on education and health can additionally increase labor productivity. In addition to rural electrification's effects on educational and health outcomes, the following years saw a plethora of studies investigating causal impacts on additional impact categories. Figure C.A1 provides a simplified but intuitive theory of change framework which, based on an in-depth review of the related literature, illustrates how electricity access can ultimately result in positive socioeconomic impacts for rural people in low-income countries. This framework will be elaborated on in the remainder of this chapter and will also serve as the basis for the impact analysis presented in this paper.

Figure C.A1 – Rural Electrification Theory of Change



Source: Original illustration based on literature review, Khandker et al. (2013) and Lenz et al. (2017).

As displayed in Figure C.A1, the first requirement for electrification endeavors to bring about positive socioeconomic change is that households exposed to the novel technology are enabled to take up electricity and then start incorporating electricity into their daily lives in the first place. While experimental evidence from rural areas in low-income countries shows that the demand for an electricity connection can fall sharply with increasing prices (Lee et al., 2020), many electrification projects involve the dissemination of grid connections or SHS free of charge. Intuitively, given the positive promise of electricity with regards to an increase in productivity and the simplification of everyday chores, one would assume that electricity uptake should be regarded as a given if rural households are provided with free or heavily subsidized access. However, rigorous impact evaluation studies of different rural electrification projects provide mixed evidence across different types of electricity sources. While some studies find evidence for extensive use patterns of new connections to the electricity grid (Burlig & Preonas, 2016), others show that electricity consumption only increases marginally despite a sizeable share of new connections (Lenz et al., 2017). Similar patterns are observed when analyzing the literature on rural electrification projects involving SHS dissemination. While one RCT provides evidence for intensive electricity use, even if SHS are disseminated to rural households entirely free of charge (Grimm et al., 2017), another RCT communicates a much bleaker outlook with regard to electricity uptake (Aklin et al., 2017).

Naturally, electricity can only have an effect on socioeconomic development if it can be put to effective use by means of electric appliances. Especially in cases of rural electrification projects involving low-tier solar energy systems, households are typically provided with SHS starter kits (or Pico-PV kits) involving a few light bulbs (Grimm et al., 2017). However, the vast majority of electric appliances listed in Figure C.A1 would need to be acquired by the households themselves. In socioeconomic environments, often characterized by poverty and low credit accessibility, it is clear that the appliance uptake itself represents a crucial step in safeguarding socioeconomic benefits from electricity access. Literature reports an increase in appliance uptake and use in response to both grid (Lenz et al., 2017) and SHS electrification. Apart from lighting devices, SHS impact evaluations find evidence for increased adoption and usage of appliances like mobile phones, radios, fans, and TVs (Bensch et al., 2013; Diallo & Moussa, 2020; Wagner et al., 2021).

Before continuing our discussion of the theory of change presented in Figure A1, we deem it crucial to point out that neither the uptake of electricity itself nor the adoption and use of suitable appliances can be evaluated in a vacuum. In fact, the empirical literature concerning household electrification is naturally characterized by varying sociocultural study contexts and heterogeneity with regards to both evaluated development indicators and applied impact identification methodology (ranging from RCTs to quasi-experimental methodology like the application of instrumental variables, regression discontinuity design or propensity score matching approaches). The variation in empirical findings, with many studies reporting no welfare effects at all, can also be attributed to complementary inputs that must be available to households besides electric appliances: Employment and subsequently incomes might only increase if growing businesses are present in a region that is newly electrified, while transport infrastructure might also be necessary to connect rural laborers with their workplace (Lee et al., 2017). In addition, if households have no access to credit and loan facilities to finance investments in electric appliances, positive impacts on household expenditure and income might not materialize at all.

C.A.C. Evidence on the Socioeconomic Impact of Rural Electrification

As indicated in chapter 4.2.2., the socioeconomic development indicators typically investigated in the literature on rural electrification effects can be clearly grouped into three categories: income, health, and education. Electrification effects on income are measured along different sets of indicators and, as for all impact categories discussed in this section, results across different studies are not perfectly consistent, likely based on the heterogeneity in contextual factors and variations across complementary inputs between studies, as outlined in chapter 4.2.2. The most straightforward indicator for measuring electrification effects on household income would be changes in income and/or expenditure patterns. With regards to grid-based electrification, a number of studies report positive impacts on household expenditures and reported income (Chakravorty et al., 2016; Khandker et al., 2013; Lipscomb et al., 2013; van de Walle et al., 2015), which can at least partially be explained through an increase of participation in income-generating activities, specifically among women (Barron & Torero, 2017; Dinkelman, 2011; Grogan & Sadanand, 2013). These patterns however do not seem to be universal, with some studies reporting zero effects despite applying state-of-the-art impact identification methods (Burlig & Preonas, 2016; Lee et al., 2020).

With regards to solar-based electrification, literature findings on its impact on household income are equally ambiguous: Even though the power generating capacity of evaluated technologies in this literature varies from solar lanterns over pico-PV kits to solar mini-grids, most studies were able to report positive effects on household expenditures. Literature suggests that this effect is mostly driven by households becoming able to reduce energy expenditures for kerosene or other traditional, fuel-based lighting sources (Aklin et al., 2017; Samad et al., 2013), or via a reduced dependency on battery consumption for flashlights (Grimm et al., 2017; Wagner et al., 2021). Other studies provide evidence for SHS users consuming on average more high-quality light as measured in terms of lumen. This improvement is assumed to even outweigh a possible reduction of total lighting hours when compared to alternative sources (Bensch et al., 2013; Grimm et al., 2017). In some local contexts, newly electrified households also seem able to generate income from electricity through service provision, as e.g., mobile charging for neighbors (Wagner et al., 2021).

A significant share of the literature on rural electrification is concerned with its impacts on educational outcomes (typically measured through school performance or literacy). These impacts are generally assumed to be enabled through a potential increase in study time at home, which therefore also acts as an outcome variable in a number of studies. Especially in cases where children are assumed to provide assistance in the household or in the family business, they could be enabled to shift their studying endeavors into the evening or nighttime hours, when the electrical lighting sources can provide lighting of higher quality and reliability over alternative sources. Apart from that, improved educational outcomes could also be realized through facilitated access to information through mobile phones. With regards to rural grid electrification projects, literature reports positive educational outcomes with regard to literacy (Lipscomb et al., 2013), school attendance (Khandker et al., 2013; Lipscomb et al., 2013), and an increase in participation in schooling-related activities (Barron & Torero, 2017). However, other studies report only weak evidence for educational impacts (Lenz et al., 2017) or none at all (Burlig & Preonas, 2016; Dinkelman, 2011; Lee et al., 2020).

In the context of solar-based rural electrification programs, which are often carried out in more remote areas, often branded with low literacy, positive educational effects from electrification would be of special importance. This is why a number of solar electrification impact studies put educational impacts at the center of interest (Furukawa, 2014; Hassan & Lucchino, 2016). Studies almost universally report some form of an increase in study hours in response to gaining electricity access, mostly materializing in the evening hours (Bensch et al., 2013; Furukawa, 2014; Grimm et al., 2017; Hassan & Lucchino, 2016; Samad et al., 2013), whereas Aklin et al. (2017) report null effects with regards to educational outcomes.[93] It is noteworthy however, that these increases in study time do not necessarily seem to translate into improved educational outcomes as measured via test scores etc. While Hassan & Lucchino (2016) report an increase in math grades among households receiving the treatment intervention (i.e., the reception of solar lamps among 7th graders), Furukawa (2014) even reports a 5% decrease in test scores in response to the treatment (also, random solar lamp distribution among school children). While the author explains this counterintuitive finding with potential reporting bias and/or instances of flickering solar lamps, Hassan & Lucchino (2016) provide evidence for the necessity of complementary sociocultural requirements for positive educational outcomes to manifest in response to electricity access. The authors find that the main channels for the treatment to affect test scores were an increase in time spent at school during the evening, as well as co-studying among students sharing the solar lamp. This suggests the relevance of social practices and behavioral adaptation in generating welfare effects through solar electrification.

A number of studies additionally investigate how and if electrification access among rural households might lead to positive outcomes on human health. The typical assumption concerning this linkage would be improvements in indoor air quality, which are driven by a decreased dependency on fossil-based lighting or heat sources (e.g., kerosene wick lamps, or fuelwood-based cooking options). While such effects are not universally reported (Burlig & Preonas, 2016; Lee et al., 2020), a number of studies report positive health outcomes, even though it has to be mentioned that these findings are mostly weak and typically based on self-reported assessments of changes in indoor air quality and/or prevalence of respiratory diseases among household members and thus prone to reporting biases (Grimm et al., 2017; Lenz et al., 2017; Samad et al., 2013). The contribution by (Barron & Torero, 2017), however enhances this strand of the literature on rural electrification impacts by providing positive evidence for a decrease in indoor air pollution based on actual measurements of indoor fine particle concentrations. Thus, as long as fuel stacking[94] is not a common practice, electricity-powered lighting devices seem to serve as substitutes for fuel-based sources that can reduce indoor air pollution and subsequently the incidence of respiratory illnesses, especially for children and women, who generally spend more time inside (González-Eguino, 2015).

[93] This is however likely related to the authors' choice to measure their educational outcomes via a dichotomous indicator for using lighting to study. We assume this would also include traditional, fossil-based lighting sources, which would provide a probable explanation for the reported null effects.

[94] Fuel stacking is generally referred to the practice of combining traditionally established (as e.g., fuelwood or kerosene lighting) sources of energy with electricity. Such practices are quite common among newly electrified households, which stands in contrast to the energy ladder theory, which assumes that households change their fuel sources entirely as they make their way up the metaphorical energy ladder (Yadav et al., 2021).

Another group of studies investigates potential causal relationships between electricity access and fertility rates, providing evidence that electrified households show significantly lower fertility rates in rural areas, whereas the opposite holds true in urban areas (Peters & Vance, 2011). Another study shows that electrification explains a significant portion of decreases in national fertility (Grimm et al., 2015), illustrating that the linkage between electrification and fertility seems to be dependent on the development status of the electrified study area, specifically with regard to medical infrastructure. Depending on the given context, information effects triggered by electrification access might dampen fertility numbers, whereas in other cases, improvements in medical service provision via electricity access might outweigh such declines.

Apart from the literature on electrification effects on more classical indicators of human development discussed in the previous sub-chapter, a specific strand of literature is concerned with more intangible electrification impacts revolving around dimensions of well-being that might not be captured via income, educational, or health outcomes. These include potential electrification effects on concepts like life satisfaction or feelings of security during nighttime. While not all of these studies apply rigorous impact evaluation methodology and report more on a basis of descriptive case study analysis, findings regarding an increase in life satisfaction in response to rural electrification initiatives seem to be more or less consistent (Cravioto et al., 2020; Lee et al., 2020; Vernet et al., 2019), as are the findings regarding an increase in perceived nighttime security (Bensch et al., 2013; Hirmer & Guthrie, 2016; Wamukonya & Davis, 2001).

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C.B – Propensity Score Weighting Approach

In order to make treated and control households as observationally similar as possible, we apply a propensity score weighting approach. Generally, causal effects are obtained by randomizing the treatment dissemination in a predefined study group to ensure a similar distribution of confounding background characteristics among the treated and the control group at baseline. With non-experimental or rather observation data, similar to the case present in the study at hand, treated and control households differ systematically in their background characteristics that influence the probability to receive the treatment (here SHS) and the outcomes of interests. Even in absence of any treatment, the outcomes of both groups might be fundamentally different (Caliendo & Kopeinig, 2008). The idea of propensity score weighting is to find a subset of observational data that emulates a set generated by an experiment. The approach was first introduced in Rosenbaum & Rubin (1983). They suggested matching treated and potential control units according to their probability to receive treatment, which is generally referred to as their propensity scores. The propensity score is a means of balancing the distribution of confounding baseline variables between the treated and the control group (Austin, 2011). In sum, a dataset with treated and control units with a similar distribution of their propensity scores should also have a similar distribution of background characteristics, as long as the propensity scores of the two treatment arms overlap.

Ensuring a certain degree of objectivity in modeling the socioeconomic outcomes, we did not consult the outcomes of interest until the treatment probability was modeled and a balanced sample was obtained (Rubin, 2008; Varadhan & Seeger, 2013). This procedure ensures that post-weighting modeling does not distort estimates toward an author's preferred hypothesis. Moreover, in estimating the treatment assignment, we only considered variables theoretically related to the outcomes of interests and/or a combination of variables related to the outcomes of interest and the household treatment status. We excluded variables only related to the treatment status to avoid biased results and decrease the estimated treatment effect variance (Adelson et al., 2017; Brookhart et al., 2006). For modeling the treatment probability, we harnessed some of the baseline village-level data in combination with some information acquired during the cross-sectional household survey in 2020/2021. Unfortunately, no true baseline values on the household level were available to us. We thus only included household-level variables in the estimation of the propensity scores that can be assumed to be unaffected by the treatment or to be constant over time, to avoid treatment effects being distorted (Garrido et al., 2014). Following this approach, we reconstruct household-level baseline values. We used a village's distance to the coast and the next road, the village's size, and if it has a link to another administrative department as village-level explanatory variables informing the propensity score model. In addition, we deemed the age of the household's head, his/her gender, years of education and marital status, the number of children born before the distribution of the SHS, the corresponding share of male children, the number of years the household lives in the area, and material characteristics of the households dwelling as potentially confounding variables. For the evaluation of changes concerning children's study habits, we also included if the household had a child enrolled in school at baseline. The overall number of household members might be related to the treatment status and theoretically associated with several outcome indicators. However, as e.g., shown in Peters & Vance (2011), electricity might decrease household fertility in rural areas. We do find a weak and statistically insignificant correlation between the children born eight years after the last SHS was distributed and the treatment indicator and therefore conclude that average differences in household sizes between our treatment groups observed today should have also been present at baseline. Following the strategy outlined above, we estimated two propensity score models for both main empirical approaches (ITT & AT). These propensity scores were estimated via a logit regression, and we calculated the predicted probability of treatment afterward.

For weighting observations based on their propensity score and thereby balancing socio-economic background characteristics, we applied a relatively novel approach called overlap weighting (OW), first introduced by Li et al. (2017). In this approach, the probability to be assigned to the opposite treatment arm is used as a weight for each observation.[95] The method has several appealing features and statistical properties suited for our case study: It bounds the weights between 0 and 1 and allows to estimate an unbiased average treatment effect for the overlap population in cases in which the overlap in propensity scores is not extensive (as in our case). Furthermore, it addresses problems related to other propensity score weighting methods under weak common support that emerge from propensity scores close to 0 or 1. These observations tend to have large weights that tend to dominate estimation results, and earlier methods recommend ad hoc trimming procedures to handle such difficulties (Thomas et al., 2020). Nevertheless, the OW approach outperforms inverse-probability weighting (IPW) in terms of bias and variance, and even trimmed IPW appears to be less efficient in most scenarios and can fall short in terms of confidence interval coverage (Li & Thomas, 2019). An additional advantage of OW is that the method yields an exact balance in the means of covariates included in the propensity score model. Furthermore, we assume that the weighting process also balances all unobserved variables that are correlated with the ones included in the propensity score model (Stuart, 2010). As balance evaluation metrics we used standardized mean differences. A weighted sample can be regarded as sufficiently balanced when the standardized mean differences of confounding variables are below 0.25. This definition of the tolerance levels of imbalance is based on the decision to apply regression adjustment as a means to model the causal relationship between the treatment and the outcomes. The literature on propensity score weighting and matching suggest that these thresholds are sufficient to remove residual imbalances between the treated and the control group when the treatment effects are estimated via regression adjustment (Rubin, 2001; Stuart, 2010). Furthermore, we report the pseudo-R-squared before and after weighting, as well as the results of a likelihood ratio test of joint insignificance (Sianesi, 2004). In summary, the weighting

[95] Treated units receive the counter probability of being treated, and control units the probability to be treated as weight.

is set up in a way that observations with extreme propensity scores contribute less to the treatment effect estimation relative to observations with overlapping and comparable background characteristics (Thomas et al., 2020).

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C.C – Additional Tables and Figures

Table C.C1 – LCI of SHS Components as Employed in (Antonanzas-Torres et al., 2021)

Component	Value	Unit
Polycrystalline silicon PV module (per kW)		
Silicon solar cell	5.15	m^2
Aluminum alloy	10.61	kg
Solder, tin	0.138	kg
Solder, copper	0.583	kg
Glass	30.89	kg
Ethylvinylacetate, foil	4.54	kg
Back foil, PVDE	0.588	kg
Back foil, PET	1.963	kg
Corrugated board box	6.25	kg
Water	106.23	kg
Electricity	519	kWh
LAB (per kg)		
Polypropylene	0.06	kg
Sulfuric acid	0.08	kg
Tap water	0.127	kg
Lead	0.7	kg
Glass fiber	0.02	kg
Electricity	0.256	kWh
Heat, natural gas	1.504	MJ
Cable (per m)		
Copper	0.0061	kg
Plastic pipes	0.0134	kg
Glass fiber	0.00775	kg
Polyethylene	0.01342	kg
Charge controller (item)		
Polyvinyl chloride	0.06	kg
Integrated circuit	0.013	kg
Transistor wired	5.9×10^{-4}	kg

Table C.C2 - Household Members Born After SCCDP Intervention

	ITT		AT	
	Spearman's rank correlation coefficient	OLS correlation coefficient	Spearman's rank correlation coefficient	OLS correlation coefficient
	Number children born 8 years after SHS dissemination			
SHS	0.0059	0.0577	0.0237	0.1082
N	760	760	405	405

* p < 0.10, ** p < 0.05, *** p < 0.01

Table C.C3 - Propensity Score Estimation

	ITT	AT
	SHS	SHS
Village distance to coast in km	-0.0543*** (0.00676)	-0.0508*** (0.00958)
Village distance to nearby road in km	0.730*** (0.0819)	0.682*** (0.101)
Village size (Total number of households)	0.00696 (0.00676)	-0.00780 (0.00782)
Village has no link to other administrative department	-0.242 (0.298)	-0.488 (0.379)
Household head is female	-0.889** (0.371)	-0.416 (0.457)
Age household head (years)	0.00442 (0.00968)	-0.00201 (0.0124)
Household head years of education	-0.0562* (0.0309)	0.0245 (0.0372)
Household head is married	-0.409 (0.524)	0.129 (0.750)
Number of children	0.167* (0.0945)	0.192* (0.111)
Share of male children (in percent)	0.272 (0.290)	0.233 (0.377)
Years of residence	-0.000820 (0.00523)	0.00560 (0.00668)
Roof is made of wood/straw/mud	0.703** (0.299)	1.043** (0.428)
Floor is made of earth/wood/stones	1.353*** (0.384)	2.062*** (0.464)
Wall is made of earth/wood/straw	1.119* (0.604)	1.304* (0.748)
Child enrolled in school at baseline	-1.466*** (0.537)	-1.975*** (0.745)
Number of household members	-0.0253 (0.0318)	0.0417 (0.0389)
Constant	-1.253 (0.945)	-3.555*** (1.262)
Observations	760	405
Pseudo R^2	0.350	0.399

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.C4 - ITT Sample-Based Balance Table

Variable	Raw (unweighted)			weighted		
	Mean treated	Mean control	Standardized diff.	Mean treated	Mean control	Standardized diff.
Village distance to coast in km	10.43	25.66	-0.942	16.25	16.25	0.000
Village distance to nearby road in km	4.69	1.53	0.902	1.76	1.76	0.000
Village size (Total number of households)	32.44	29.85	0.150	33.97	33.97	0.000
Village has no link to other administrative department	0.80	0.86	-0.168	0.87	0.87	0.000
Age household head	45.38	43.13	0.185	44.54	44.54	0.000
Household head years of education	1.56	2.18	-0.170	1.94	1.94	0.000
Household head is female	0.09	0.14	-0.158	0.12	0.12	0.000
Household head is married	0.95	0.95	-0.017	0.95	0.95	0.000
Number of children >8 years old	1.72	1.34	0.262	1.52	1.52	0.000
Share of male children >8 years old (in percent)	0.42	0.36	0.161	0.38	0.38	0.000
Years of residence	43.53	41.57	0.081	43.87	43.87	0.000
Roof is made of wood/straw/mud	0.88	0.82	0.188	0.84	0.84	0.000
Floor is made of earth/wood/stones	0.14	0.08	0.180	0.10	0.10	0.000
Wall is made of earth/wood/straw	0.97	0.96	0.058	0.95	0.95	0.000
Child with >7 schooling years	0.03	0.06	-0.124	0.05	0.05	0.000
Household size	9.12	8.01	0.261	8.51	8.51	0.000
Number of enrolled children	0.56	0.61	-0.043	0.56	0.61	-0.054
N		760			744	
N(treated)		554			538	
N(control)		206			206	
Pseudo-R^2		0.35			0.00	
Chi^2		142.27			0.00	
Prob>Chi^2		0.00			1.00	

Table C.C5 - AT Sample-Based Balance Table

Variable	Raw (unweighted)			weighted		
	Mean treated	Mean control	Standardized diff.	Mean treated	Mean control	Standardized diff.
Village distance to coast in km	9.25	25.66	-1.028	14.19	14.19	0.000
Village distance to nearby road in km	5.07	1.53	0.800	1.85	1.85	0.000
Village size (Total number of households)	32.66	29.85	0.172	33.07	33.07	0.000
Village has no link to other administrative department	0.74	0.86	-0.303	0.85	0.85	0.000
Age household head	45.12	43.13	0.163	44.62	44.62	0.000
Household head years of education	2.22	2.18	0.009	2.32	2.32	0.000
Household head is female	0.13	0.14	-0.044	0.14	0.14	0.000
Household head is married	0.96	0.95	0.067	0.96	0.96	0.000
Number of children >8 years old	1.92	1.34	0.404	1.71	1.71	0.000
Share of male children >8 years old (in percent)	0.43	0.36	0.175	0.41	0.41	0.000
Years of residence	46.89	41.57	0.220	45.94	45.94	0.000
Roof is made of wood/straw/mud	0.91	0.82	0.275	0.86	0.86	0.000
Floor is made of earth/wood/stones	0.23	0.08	0.416	0.13	0.13	0.000
Wall is made of earth/wood/straw	0.95	0.96	-0.007	0.95	0.95	0.000
Child with >7 schooling years	0.03	0.06	-0.137	0.04	0.04	0.000
Household size	9.93	8.01	0.453	9.16	9.16	0.000
Number of enrolled children	0.51	0.61	-0.097	0.58	0.65	-0.064
N		405			404	
N(treated)		199			198	
N(control)		206			206	
Pseudo-R^2		0.39			0.00	
Chi^2		97.87			0.00	
Prob>Chi^2		0.00			1.00	

Table C.C6 - Differences in Ownership of Electric Appliances and Lighting Devices

	Predicted control mean (ITT)	ATO (ITT)	Predicted control mean (AT)	ATO (AT)
	Ownership of different electric appliances			
Owns mobile phones (%)	0.673	0.121**	0.6897	0.198***
	(0.037)	[0.023, 0.217]	(0.043)	[0.095, 0.299]
Number of mobile phones owned	0.772	0.535***	0.804	0.879***
	(0.059)	[0.322, 0.748].	(0.083)	[0.52, 1.238]
Owns fans/ventilators (%)	0.012	0.0389***	0.005	0.061**
	(0.008)	[0.015, 0.063]	(0.004)	[0.009, 0.113]
Owns radio (%)	0.043	0.003	0.059	0.019
	(0.011)	[-0.029, 0.036]	(0.016)	[-0.040, 0.078]
Owns TV (%)	0	0.014**	0	0.028*
	(0.0015)	[0.001, 0.028]	(0.003)	[-0.003, 0.058]
	Ownership of different lighting devices			
Owns lightbulbs (%)	0.116	0.217***	0.137	0.282***
	(0.021)	[0.148, 0.286]	(0.025)	[0.193, 0.371]
Owns battery lamp (%)	0.540	-0.22***	0.535	-0.42***
	(0.033)	[-0.323, -0.117]	(0.036)	[-0.521, -0.319]
Owns solar torch (%)	0.256	-0.068*	0.268	-0.257***
	(0.032)	[-0.144, 0.007]	(0.025)	[-0.309, -0.204]
Owns no lighting source (%)	0.201	0.048	0.202	0.263***
	(0.037)	[-0.042, 0.137]	(0.037)	[0.150, 0.377]

Note: We used Probit and OLS regression analysis and calculated predicted values based on the respective models to obtain a covariate adjusted difference in means and proportions. The parentheses below the predicted control mean contain the prediction 's standard error. 95 % confidence interval in brackets. p<0.10*, p<0.05**, p<0.01***.

Table C.C7 - Full Output – Unweighted Regression of Electricity Uptake and Lighting Usage on SHS

	ITT		AT	
	Total electric appliances (OLS)	Total daily light hours (OLS)	Total electric appliances (OLS)	Total daily light hours (OLS)
SHS	0.512*** [0.284,0.740]	-0.346 [-1.038,0.346]	0.866*** [0.557,1.175]	-1.657*** [-2.420,-0.893]
Village distance to coast in km	0.007** [0.001,0.013]	0.011 [-0.008,0.029]	0.007* [-0.000,0.015]	-0.001 [-0.023,0.020]
Village distance to nearby road in km	0.000 [-0.019,0.020]	0.074** [0.014,0.133]	-0.019 [-0.043,0.005]	0.134*** [0.062,0.207]
Village size (Total number of households)	0.000 [-0.006,0.006]	0.016** [0.001,0.031]	0.002 [-0.005,0.008]	0.010 [-0.007,0.028]
Village has no link to other administrative department	-0.090 [-0.306,0.127]	-0.183 [-1.013,0.647]	0.003 [-0.319,0.325]	-0.154 [-1.052,0.743]
Household head is female	0.249 [-0.169,0.667]	-0.303 [-0.969,0.362]	0.052 [-0.208,0.312]	-0.208 [-0.897,0.481]
Age household head (years)	-0.005 [-0.012,0.002]	-0.009 [-0.027,0.009]	0.000 [-0.009,0.009]	-0.001 [-0.023,0.020]
Household head years of education	0.088*** [0.052,0.124]	0.035 [-0.022,0.092]	0.073*** [0.033,0.112]	0.067** [0.005,0.128]
Household head is married	0.203 [-0.105,0.512]	-0.289 [-1.199,0.621]	-0.158 [-0.573,0.256]	0.388 [-0.556,1.332]
Number of children	-0.014 [-0.090,0.062]	0.015 [-0.135,0.164]	-0.067 [-0.156,0.022]	-0.066 [-0.254,0.121]
Share of male children (in percent)	0.149 [-0.094,0.393]	0.692*** [0.185,1.198]	0.371** [0.027,0.715]	0.711** [0.044,1.377]
Years of residence	0.002 [-0.002,0.006]	0.012* [-0.001,0.026]	0.002 [-0.002,0.006]	0.014* [-0.001,0.030]
Roof is made of wood/straw/mud	0.127 [-0.128,0.382]	0.127 [-0.527,0.781]	0.011 [-0.299,0.321]	0.158 [-0.567,0.884]
Floor is made of earth/wood/stones	0.190 [-0.123,0.502]	-0.553 [-1.236,0.130]	-0.038 [-0.455,0.380]	-0.027 [-0.864,0.809]

Wall is made of earth/wood/straw	-1.209** [-2.267,-0.150]	-0.277 [-1.270,0.716]	-0.909 [-2.040,0.222]	0.437 [-0.633,1.508]
Child enrolled in school at baseline	-0.263* [-0.565,0.039]	-1.013** [-1.877,-0.150]	-0.166 [-0.542,0.211]	-1.179** [-2.140,-0.217]
Household size	0.087*** [0.055,0.118]	-0.009 [-0.068,0.049]	0.078*** [0.036,0.121]	0.011 [-0.062,0.084]
Constant	0.797 [-0.358,1.952]	2.968*** [1.023,4.914]	0.767 [-0.628,2.162]	1.380 [-0.760,3.520]
Observations	760	760	405	405

95% confidence intervals in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.C8 - Full Output – Unweighted Regression of Health Outcomes on SHS

	ITT		AT	
	HH member with breathing problems (Probit)	Healthstatus (Tobit)	HH member with breathing problems (Probit)	Healthstatus (Tobit)
SHS	-0.262* [-0.559,0.036]	-0.066 [-0.479,0.348]	-0.358* [-0.730,0.015]	-0.201 [-0.758,0.356]
Village distance to coast in km	-0.007 [-0.016,0.002]	0.013* [-0.000,0.025]	-0.007 [-0.017,0.003]	0.013 [-0.004,0.029]
Village distance to nearby road in km	0.005 [-0.021,0.031]	0.031** [0.002,0.061]	0.005 [-0.024,0.035]	0.032 [-0.013,0.076]
Village size (Total number of households)	0.004 [-0.004,0.011]	0.008* [-0.001,0.017]	0.002 [-0.006,0.009]	0.009 [-0.003,0.022]
Village has no link to other administrative department	-0.134 [-0.472,0.205]	-0.304 [-0.713,0.105]	-0.336 [-0.737,0.065]	-0.287 [-0.975,0.402]
Household head is female	0.047 [-0.330,0.424]	-0.585*** [-0.971,-0.199]	0.035 [-0.411,0.481]	-0.565** [-1.033,-0.097]
Age household head (years)	0.016*** [0.005,0.027]	-0.008 [-0.021,0.006]	0.017** [0.003,0.031]	-0.005 [-0.022,0.012]
Household head years of education	0.001 [-0.034,0.037]	-0.009 [-0.045,0.028]	0.008 [-0.031,0.048]	-0.023 [-0.067,0.020]
Household head is married	-0.244 [-0.736,0.248]	-0.029 [-0.704,0.647]	-0.002 [-0.792,0.789]	-0.082 [-1.157,0.992]
Number of children	0.087* [-0.007,0.181]	-0.060 [-0.188,0.067]	0.066 [-0.041,0.173]	-0.086 [-0.236,0.063]
Share of male children (in percent)	-0.032 [-0.282,0.218]	0.036 [-0.272,0.344]	-0.151 [-0.552,0.249]	0.247 [-0.189,0.684]
Years of residence	-0.005 [-0.011,0.002]	-0.004 [-0.013,0.005]	-0.007 [-0.015,0.001]	-0.003 [-0.013,0.007]
Roof is made of wood/straw/mud	0.353* [-0.057,0.762]	0.575** [0.090,1.061]	0.443 [-0.170,1.056]	0.724** [0.064,1.385]
Floor is made of earth/wood/stones	0.191 [-0.110,0.492]	-0.019 [-0.466,0.428]	0.124 [-0.335,0.583]	0.029 [-0.594,0.653]
Wall is made of earth/wood/straw	-0.450 [-1.124,0.224]	-0.107 [-0.719,0.506]	-0.384 [-1.292,0.523]	-0.329 [-0.986,0.328]

Child enrolled in school at baseline	0.209 [-0.265,0.683]	0.543 [-0.302,1.388]	0.035 [-0.699,0.768]	0.165 [-0.917,1.247]
Household size	0.017 [-0.016,0.050]	-0.059** [-0.104,-0.013]	0.042** [0.002,0.082]	-0.041 [-0.096,0.015]
Constant	-1.277*** [-2.247,-0.308]	2.235*** [0.931,3.539]	-1.502** [-2.953,-0.050]	1.981** [0.241,3.722]
var(e.overallhealth)		2.915*** [2.259,3.570]		2.974*** [2.173,3.776]
Marginal difference	-0.063* [-0.136, 0.010]		-0.081* [-0.164, 0.001]	
Observations	760	760	405	405

95% confidence intervals in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.C9 - Full Output – Unweighted Regression of Educational Outcomes on SHS

	ITT		AT	
	Total daily study hours (ZINB)	Total study hours after nightfall (ZINB)	Total daily study hours (ZINB)	Total study hours after nightfall (ZINB)
SHS	0.322** [0.051,0.593]	-0.207 [-0.687,0.274]	0.416*** [0.146,0.685]	-0.545 [-1.279,0.190]
Village distance to coast in km	0.007 [-0.001,0.015]	0.001 [-0.014,0.016]	0.004 [-0.004,0.012]	-0.009 [-0.024,0.006]
Village distance to nearby road in km	0.015 [-0.034,0.064]	0.054 [-0.038,0.146]	0.021 [-0.065,0.106]	0.113** [0.008,0.218]
Village size (Total number of households)	0.004 [-0.002,0.011]	-0.005 [-0.019,0.009]	0.001 [-0.009,0.011]	-0.003 [-0.027,0.022]
Village has no link to other administrative department	0.201 [-0.399,0.802]	0.770 [-0.236,1.776]	0.119 [-0.408,0.645]	0.281 [-0.703,1.266]
Household head is female	-0.655** [-1.292,-0.017]	-0.157 [-0.862,0.547]	-0.707* [-1.446,0.032]	-0.346 [-1.296,0.604]
Age household head (years)	-0.008 [-0.019,0.004]	-0.003 [-0.027,0.021]	-0.010 [-0.025,0.006]	0.004 [-0.026,0.034]
Household head years of education	0.011 [-0.018,0.040]	0.022 [-0.023,0.066]	0.010 [-0.020,0.040]	0.011 [-0.038,0.059]
Household head is married	1.770*** [0.576,2.964]	14.843*** [13.601,16.086]	1.844* [-0.200,3.888]	14.206*** [12.973,15.440]
Number of children	0.149*** [0.040,0.259]	0.133 [-0.058,0.324]	0.257*** [0.143,0.372]	0.142 [-0.065,0.350]
Share of male children (in percent)	0.228 [-0.086,0.541]	0.674*** [0.164,1.183]	0.099 [-0.296,0.495]	0.641* [-0.115,1.396]
Years of residence	0.005 [-0.003,0.013]	-0.006 [-0.018,0.007]	0.004 [-0.004,0.013]	-0.014* [-0.029,0.001]
Roof is made of wood/ straw/mud	0.625*** [0.237,1.013]	0.127 [-0.296,0.551]	0.424** [0.101,0.748]	-0.031 [-0.498,0.435]
Floor is made of earth/ wood/ stones	-0.582** [-1.041,-0.123]	-0.592* [-1.206,0.021]	-1.001*** [-1.333,-0.669]	-0.599 [-1.357,0.159]
Wall is made of earth/ wood/ straw	-1.266*** [-1.804,-0.728]	-0.962** [-1.860,-0.064]	-1.324*** [-1.804,-0.843]	-0.832 [-1.933,0.269]

Child enrolled in school at baseline	0.380** [0.063,0.696]	0.700*** [0.287,1.114]	0.361* [-0.053,0.774]	0.784** [0.176,1.391]
Household size	0.013 [-0.022,0.047]	0.011 [-0.037,0.059]	0.014 [-0.026,0.053]	0.032 [-0.035,0.100]
Constant	-0.382 [-1.870,1.105]	-14.938*** [-16.943,-12.933]	0.010 [-2.012,2.031]	-14.052*** [-16.428,-11.677]
inflate				
Number children enrolled	-4.852*** [-5.876,-3.828]	-5.021*** [-6.520,-3.523]	-5.136*** [-6.732,-3.539]	-5.534*** [-8.205,-2.862]
Constant	3.894*** [3.224,4.565]	4.702*** [3.313,6.090]	4.055*** [3.077,5.033]	4.741*** [2.774,6.708]
lnalpha	-0.869*** [-1.221,-0.517]	-0.607 [-1.375,0.161]	-1.272*** [-1.814,-0.730]	-0.763* [-1.672,0.146]
Marginal difference	0.543** [0.104, 0.982]	-0.076 [-0.260, 0.108]	0.745*** [0.235, 1.255]	-0.186 [-0.446, 0.075]†
Observations	760	760	405	405

† The marginal difference between SHS users and non-users is based on regression that does not control for a household's years of residence to avoid computational difficulties concerning confidence intervals and p-values. 95% confidence intervals in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.C10 - Full Output – Unweighted Regression of Economic and Non-Economic Outcomes on SHS

	ITT		
	Total monthly expenditures p.c. (log) (OLS)	Life satisfaction (Tobit)	Feeling of security at night (Tobit)
SHS	-0.009 [-0.157,0.138]	0.058 [-0.369,0.484]	0.092 [-1.176,1.360]
Village distance to coast in km	0.001 [-0.004,0.005]	0.010* [-0.002,0.023]	0.040** [0.002,0.077]
Village distance to nearby road in km	0.007 [-0.002,0.017]	0.035** [0.006,0.064]	-0.009 [-0.106,0.088]
Village size (Total number of households)	-0.003** [-0.006,-0.001]	-0.003 [-0.014,0.009]	-0.029*** [-0.052,-0.007]
Village has no link to other administrative department	0.208** [0.044,0.372]	0.200 [-0.212,0.611]	1.571** [0.297,2.845]
Household head is female	-0.008 [-0.237,0.222]	-0.355 [-0.830,0.120]	3.972*** [2.636,5.307]
Age household head (years)	0.009*** [0.005,0.013]	0.004 [-0.011,0.020]	0.048*** [0.018,0.078]
Household head years of education	0.017** [0.001,0.033]	0.065*** [0.017,0.113]	0.068 [-0.025,0.160]
Household head is married	0.168 [-0.111,0.447]	0.220 [-0.268,0.708]	1.608** [0.033,3.184]
Number of children	-0.045** [-0.084,-0.006]	-0.033 [-0.147,0.081]	0.155 [-0.112,0.422]
Share of male children (in percent)	-0.012 [-0.115,0.092]	0.361** [0.004,0.717]	0.844*** [0.235,1.452]
Years of residence	-0.000 [-0.003,0.003]	-0.007 [-0.015,0.001]	-0.035*** [-0.056,-0.014]
Roof is made of wood/straw/mud	-0.090 [-0.224,0.045]	0.545** [0.054,1.036]	-0.580 [-1.666,0.505]
Floor is made of earth/wood/stones	-0.012 [-0.193,0.169]	0.184 [-0.227,0.595]	-1.010 [-2.336,0.315]
Wall is made of earth/wood/straw	-0.291* [-0.628,0.046]	0.436 [-0.425,1.298]	-1.532 [-3.478,0.414]
Child enrolled in school at baseline	0.176 [-0.064,0.416]	0.331 [-0.642,1.303]	0.153 [-1.398,1.703]
Household size	-0.064*** [-0.076,-0.053]	-0.016 [-0.062,0.031]	-0.169*** [-0.245,-0.094]
Constant	1.223*** [0.609,1.838]	0.505 [-0.882,1.892]	-0.798 [-4.018,2.421]
var(e.lifesatisfaction/Feeling of Security)		2.715*** [2.004,3.426]	12.360*** [8.709,16.010]
Observations	760	760	760

95% confidence intervals in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p<0.01$

Table C.C11 - Full Output – Unweighted Regression of Economic and Non-Economic Outcomes on SHS

	AT		
	Total monthly expenditures p.c. (log) (OLS)	Life satisfaction (Tobit)	Feeling of security at night (Tobit)
SHS	-0.019 [-0.196,0.159]	0.098 [-0.349,0.545]	0.244 [-0.909,1.398]
Village distance to coast in km	0.002 [-0.003,0.007]	0.019** [0.004,0.034]	0.059*** [0.018,0.100]
Village distance to nearby road in km	0.015*** [0.005,0.026]	0.044*** [0.015,0.073]	-0.028 [-0.113,0.056]
Village size (Total number of households)	-0.001 [-0.005,0.002]	0.014* [-0.000,0.029]	-0.022 [-0.052,0.008]
Village has no link to other administrative department	0.200* [-0.011,0.411]	0.014 [-0.511,0.540]	1.308* [-0.089,2.705]
Household head is female	-0.006 [-0.228,0.215]	-0.166 [-0.761,0.428]	4.716*** [3.179,6.252]
Age household head (years)	0.009*** [0.004,0.015]	0.005 [-0.015,0.025]	0.046** [0.001,0.091]
Household head years of education	0.018* [-0.002,0.037]	0.047 [-0.012,0.107]	0.012 [-0.104,0.127]
Household head is married	0.092 [-0.320,0.504]	0.531 [-0.261,1.323]	2.906** [0.204,5.608]
Number of children	-0.020 [-0.075,0.035]	-0.077 [-0.245,0.092]	-0.112 [-0.486,0.263]
Share of male children (in percent)	-0.108 [-0.261,0.045]	0.373* [-0.025,0.772]	0.602 [-0.331,1.534]
Years of residence	-0.001 [-0.003,0.002]	-0.010** [-0.019,-0.001]	-0.039*** [-0.068,-0.011]
Roof is made of wood/straw/mud	-0.206** [-0.380,-0.031]	0.274 [-0.353,0.901]	-1.518* [-3.213,0.176]
Floor is made of earth/wood/stones	-0.122 [-0.372,0.128]	0.006 [-0.538,0.550]	-1.691** [-3.245,-0.137]
Wall is made of earth/wood/straw	-0.150 [-0.556,0.257]	0.618 [-0.586,1.821]	-3.139*** [-5.186,-1.092]
Child enrolled in school at baseline	0.212 [-0.103,0.528]	0.518 [-0.668,1.705]	0.863 [-1.251,2.976]
Household size	-0.062*** [-0.077,-0.046]	-0.002 [-0.060,0.056]	-0.143*** [-0.246,-0.039]
Constant	1.144*** [0.390,1.898]	-0.272 [-1.830,1.286]	0.378 [-3.535,4.291]
var(e.lifesatisfaction/Feeling of Security)		2.658*** [1.716,3.600]	13.406*** [8.914,17.897]
Observations	405	405	405

C.D – SHS Simulation Report

Version 7.3.2

PVsyst - Simulation report

Standalone system

Project: SCCDP Case Study

Variant: SCCDP v1

Standalone system with batteries

System power: 30 Wp

Sujawal - Pakistan

Author
Marco Nilgen (Germany)

Project: SCCDP Case Study

Variant: SCCDP v1

Marco Nilgen (Germany)

Project summary

Geographical Site	Situation		Project settings	
Sujawal	Latitude	24.60 °N	Albedo	0.20
Pakistan	Longitude	68.07 °E		
	Altitude	8 m		
	Time zone	UTC+5		

Meteo data
Sujawal
PVGIS api TMY

System summary

Standalone system — **Standalone system with batteries**

PV Field Orientation		User's needs	
Fixed plane		Daily household consumers	
Tilt/Azimuth	30 / 0 °	Constant over the year	
		Average	0.1 kWh/Day

System information

PV Array		Battery pack	
Nb. of modules	1 unit	Technology	Lead-acid, sealed, Gel
Pnom total	30 Wp	Nb. of units	1 unit
		Voltage	12 V
		Capacity	5 Ah

Results summary

Useful energy from solar	21.79 kWh/year	Specific production	726 kWh/kWp/year	Perf. Ratio PR	30.65 %
Missing Energy	0.11 kWh/year	Available solar energy	57.34 kWh/year	Solar Fraction SF	99.52 %
Excess (unused)	30.09 kWh/year				

Table of contents

General parameters

Standalone system — **Standalone system with batteries**

PV Field Orientation

Orientation		Sheds configuration	Models used	
Fixed plane		No 3D scene defined	Transposition	Perez
Tilt/Azimuth	30 / 0 °		Diffuse	Imported
			Circumsolar	separate

User's needs
Daily household consumers
Constant over the year
Average 0.1 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Generic
Model	Poly 30 Wp 36 cells
(Original PVsyst database)	
Unit Nom. Power	30 Wp
Number of PV modules	1 unit
Nominal (STC)	30 Wp
Modules	1 String x 1 In series
At operating cond. (50°C)	
Pmpp	29 Wp
U mpp	14 V
I mpp	2.1 A

Battery

Manufacturer	Generic
Model	Solar S12/6.6 S
Technology	Lead-acid, sealed, Gel
Nb. of units	1 Unit
Discharging min. SOC	20.0 %
Stored energy	0.0 kWh
Battery Pack Characteristics	
Voltage	12 V
Nominal Capacity	5 Ah (C10)
Temperature	Fixed 25 °C

Controller

Universal controller	
Technology	DC-DC converter
Temp coeff.	-5.0 mV/°C/Elem.
Converter	
Maxi and EURO efficiencies	97.0 / 95.0 %
DC Input voltage	0.0 V

Battery Management control

Threshold commands as	SOC calculation
Charging	SOC = 0.92 / 0.75
approx.	14.4 / 12.4 V
Discharging	SOC = 0.20 / 0.45
approx.	11.4 / 12.1 V

Total PV power

Nominal (STC)	0.030 kWp
Total	1 modules
Module area	0.2 m²

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 111 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 4.5 % at STC

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction (Fixed voltage) 2.5 %

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): Fresnel smooth glass, n = 1.526

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000

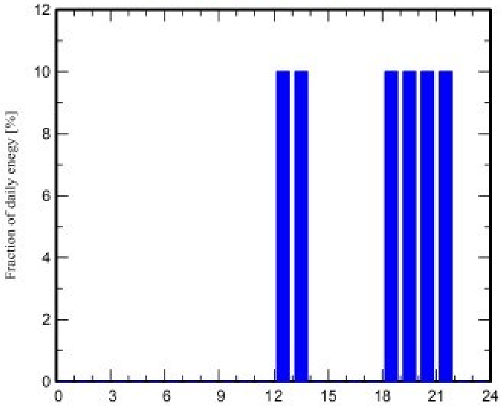
Detailed User's needs

Daily household consumers, Constant over the year, average = 0.1 kWh/day

Annual values

	Nb.	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	2	5/lamp	4.0	40
TV / PC / Mobile	2	5/app	2.0	20
Total daily energy				60

Hourly distribution

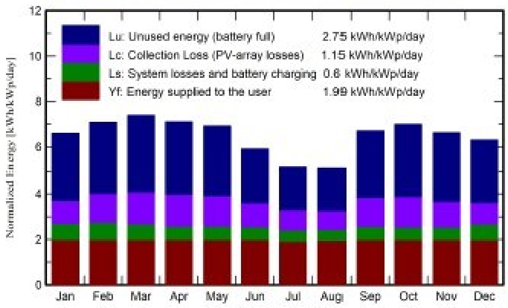


Main results

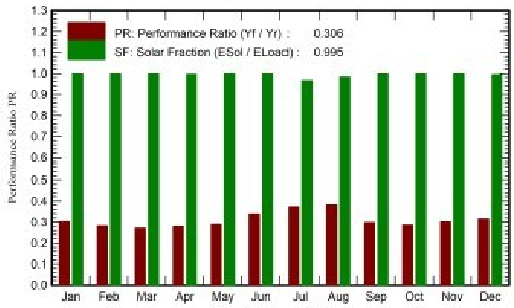
System Production

Useful energy from solar	21.79 kWh/year	Performance Ratio PR	30.65 %
Available solar energy	57.34 kWh/year	Solar Fraction SF	99.52 %
Excess (unused)	30.09 kWh/year		
Loss of Load		**Battery aging (State of Wear)**	
Time Fraction	1.4 %	Cycles SOW	26.8 %
Missing Energy	0.11 kWh/year	Static SOW	90.0 %

Normalized productions (per installed kWp)



Performance Ratio PR



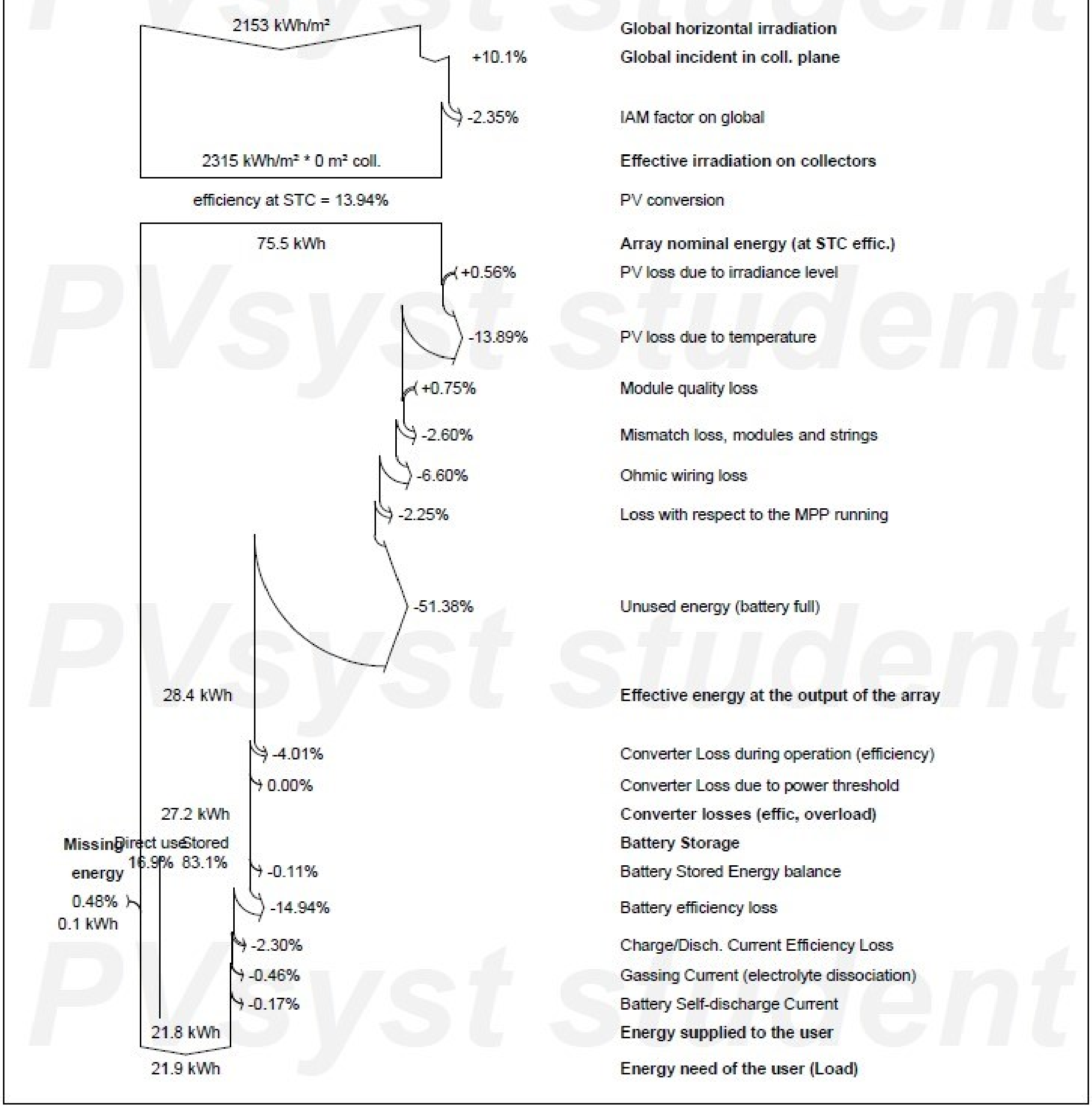
Balances and main results

	GlobHor kWh/m²	GlobEff kWh/m²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac ratio
January	144.9	201.1	5.104	2.691	0.000	1.860	1.860	1.000
February	154.8	194.3	4.790	2.564	0.001	1.679	1.680	1.000
March	203.7	224.0	5.468	3.064	0.000	1.860	1.860	1.000
April	214.7	207.6	5.043	2.805	0.003	1.797	1.800	0.998
May	237.4	207.9	5.077	2.771	0.000	1.860	1.860	1.000
June	202.7	171.6	4.273	2.065	0.000	1.800	1.800	1.000
July	180.0	156.1	3.915	1.764	0.062	1.798	1.860	0.967
August	167.7	154.6	3.912	1.736	0.030	1.830	1.860	0.984
September	189.6	196.9	4.815	2.583	0.000	1.800	1.800	1.000
October	177.8	212.6	5.164	2.881	0.000	1.860	1.860	1.000
November	145.3	195.8	4.873	2.663	0.000	1.800	1.800	1.000
December	134.6	192.3	4.901	2.505	0.009	1.851	1.860	0.995
Year	2153.2	2314.7	57.335	30.092	0.105	21.795	21.900	0.995

Legends

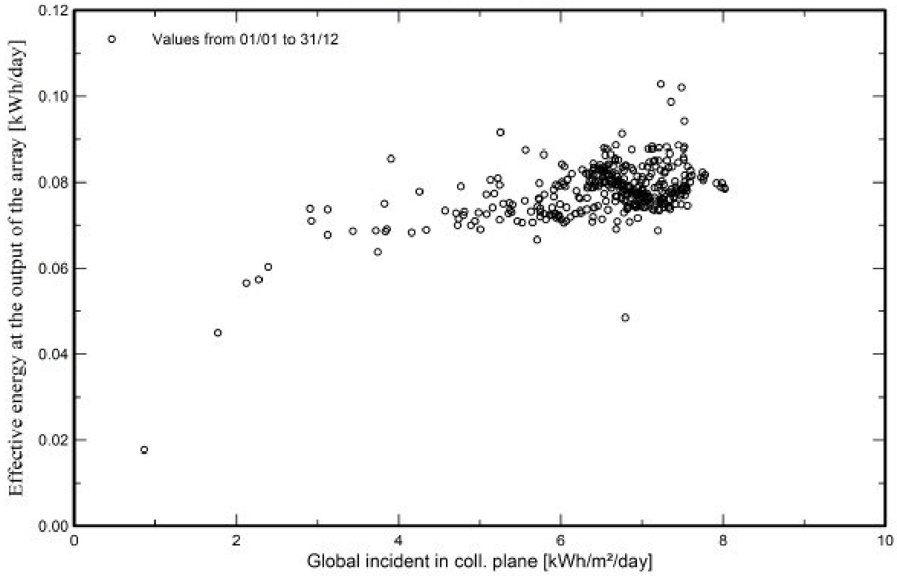
GlobHor	Global horizontal irradiation	E_User	Energy supplied to the user
GlobEff	Effective Global, corr. for IAM and shadings	E_Load	Energy need of the user (Load)
E_Avail	Available Solar Energy	SolFrac	Solar fraction (EUsed / ELoad)
EUnused	Unused energy (battery full)		
E_Miss	Missing energy		

Loss diagram



Predef. graphs

Daily Input/Output diagram



Appendix D (Chapter 5)

D.A – Additional Tables

Table D.A1 - Main DCE Results in the Preference Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

	(1)		(2)	
VARIABLES	Parameter means	Standard deviations of parameter estimates	Parameter means	Standard deviations of parameter estimates
SHS price in 1000 Pakistani Rs	-0.041***		-0.024***	
	(0.010)		(0.009)	
IFC label	0.715***	0.992***	0.761***	0.981***
	(0.064)	(0.076)	(0.079)	(0.088)
SVTC label	0.534***	0.745***	0.548***	0.654***
	(0.048)	(0.073)	(0.054)	(0.084)
Six months warranty	0.681***		0.733***	
	(0.055)		(0.062)	
One year warranty	1.236***		1.258***	
	(0.058)		(0.073)	
Two installment payments	0.582***		0.528***	
	(0.047)		(0.047)	
Three installment payments	0.655***		0.583***	
	(0.052)		(0.067)	
n	21,144	21,144	14,190	14,190
Video treatment included	YES	YES	NO	NO

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory dummy variables reflect respective attribute levels. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=1,182 participants (n=792 with video intervention excluded) and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A2 – Respondent Characteristics and SHS Preferences in the WTP Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model) without Video Treatment

	(1)		(2)		(3)		(4)	
VARIABLES	**Interaction w/ IFC label**	Standard deviation	**Interaction w/ SVTC label**	Standard deviation	**Interaction w/ full warranty**	Standard deviation	**Interaction w/ three installment**	Standard deviation
SHS price in 1000 Pakistani Rs	-3.657***	1.420***	-3.559***	1.354***	-3.590***	1.468***	-3.680***	1.368***
	(0.147)	(0.133)	(0.137)	(0.118)	(0.129)	(0.130)	(0.073)	(0.078)
HH head age interaction	0.146		-0.049		0.057		-0.174	
	(0.120)		(0.110)		(0.115)		(0.116)	
HH head education years interaction	-0.218		-0.559		1.703		-0.668	
	(1.025)		(0.840)		(1.099)		(0.945)	
HH head literacy interaction	-2.451		1.253		-6.482		3.542	
	(9.184)		(6.083)		(8.347)		(7.761)	
No. of HH members interaction	0.588*		0.207		0.399		-0.213	
	(0.352)		(0.320)		(0.377)		(0.370)	
Monthly HH expenses interaction	0.025		0.061		0.005		-0.221***	
	(0.051)		(0.056)		(0.057)		(0.080)	
Health scale interaction	-0.058		-0.589		-0.758		1.500	
	(1.613)		(1.286)		(1.481)		(1.532)	
Electricity attitude interaction	5.761**		3.185**		-4.744**		-0.142	
	(2.473)		(1.474)		(2.403)		(2.014)	
Solar attitude interaction	6.546**		3.484*		-0.491		-2.536	
	(3.025)		(2.084)		(4.234)		(3.130)	
NEP interaction	-15.669***		0.596		5.499***		2.036	
	(3.484)		(1.784)		(1.801)		(2.072)	
Life satisfaction interaction	-0.677		-0.201		0.967		-3.877**	
	(1.680)		(1.489)		(1.499)		(1.626)	
IFC label	21.214**	-19.093***	25.827***	-22.938***	26.910***	19.987***	30.675	23.283
	(8.667)	(3.144)	(4.022)	(3.231)	(3.009)	(2.739)	(0.000)	(0.000)
SVTC label	18.905***	15.123***	42.643***	-10.679***	17.754***	9.955***	20.214***	-11.770***
	(2.814)	(2.101)	(6.074)	(1.633)	(2.117)	(1.941)	(1.359)	(1.390)
Six months warranty	28.113***		11.605***		25.998***		30.176***	
	(4.470)		(1.694)		(3.580)		(1.707)	
One year warranty	47.341***		11.656***		36.386***		47.844	
	(6.867)		(1.392)		(10.974)		(0.000)	
Two installment payments	12.703***		26.912***		10.782***		13.187***	
	(2.250)		(3.195)		(1.547)		(1.649)	
Three installment payments	12.209***		6.032		11.221***		35.108***	
	(2.243)		(7.445)		(1.274)		(9.176)	
n	13,023	13,023	13,023	13,023	13,023	13,023	13,023	13,023
Video treatment included	NO	NO	NO	NO	NO	NO	NO	NO

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with socioeconomic indicator variables and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=792 participants and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A3 – Respondent Characteristics and SHS Preferences in the Preference Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

VARIABLES	(1) **Interaction w/ IFC label**	(1) Standard deviation	(2) **Interaction w/ SVTC label**	(2) Standard deviation	(3) **Interaction w/ full warranty**	(3) Standard deviation	(4) **Interaction w/ three installment**	(4) Standard deviation
SHS price in 1000 Pakistani Rs	-0.041***		-0.041***		-0.042***		-0.041***	
	(0.010)		(0.010)		(0.010)		(0.010)	
HH head age interaction	0.005		-0.001		0.003		-0.004	
	(0.004)		(0.004)		(0.004)		(0.004)	
HH head education years interaction	0.010		0.015		0.041*		0.025	
	(0.020)		(0.017)		(0.021)		(0.020)	
HH head literacy interaction	-0.229		-0.280*		-0.317*		-0.082	
	(0.171)		(0.151)		(0.188)		(0.176)	
No. of HH members interaction	0.035***		0.018*		0.037***		0.001	
	(0.014)		(0.011)		(0.012)		(0.011)	
Monthly HH expenses interaction	0.004		0.006***		0.002		-0.009***	
	(0.003)		(0.002)		(0.002)		(0.002)	
Health scale interaction	0.037		-0.029		-0.019		0.007	
	(0.054)		(0.043)		(0.054)		(0.044)	
Electricity attitude interaction	0.109*		0.166***		0.118*		-0.049	
	(0.058)		(0.054)		(0.071)		(0.068)	
Solar attitude interaction	0.065		0.117		0.110		0.169*	
	(0.088)		(0.085)		(0.097)		(0.089)	
NEP interaction	-0.210***		0.084		0.107		-0.085	
	(0.070)		(0.060)		(0.066)		(0.066)	
Life satisfaction interaction	0.008		-0.001		0.048		0.006	
	(0.060)		(0.048)		(0.058)		(0.057)	
IFC label	0.086	0.952***	0.713***	1.001***	0.720***	0.998***	0.715***	0.998***
	(0.279)	(0.080)	(0.063)	(0.081)	(0.063)	(0.083)	(0.063)	(0.081)
SVTC label	0.540***	0.762***	-0.248	0.716***	0.543***	0.764***	0.539***	0.757***
	(0.051)	(0.076)	(0.256)	(0.076)	(0.052)	(0.075)	(0.051)	(0.076)
Six months warranty	0.677***		0.681***		0.678***		0.677***	
	(0.055)		(0.054)		(0.054)		(0.054)	
One year warranty	1.235***		1.237***		0.160		1.238***	
	(0.057)		(0.057)		(0.315)		(0.056)	
Two installment payments	0.540***		0.538***		0.542***		0.542***	
	(0.052)		(0.052)		(0.051)		(0.052)	
Three installment payments	0.606***		0.607***		0.605***		0.855***	
	(0.058)		(0.058)		(0.057)		(0.270)	
n	19,470	19,470	19,470	19,470	19,470	19,470	19,470	19,470
Video treatment included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with socioeconomic indicator variables and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the preference space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Robust standard errors clustered at the village level in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A4 – Respondent Characteristics and SHS Preferences in the Preference Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model) without Video Treatment

VARIABLES	(1) **Interaction w/ IFC label**	(1) Standard deviation	(2) **Interaction w/ SVTC label**	(2) Standard deviation	(3) **Interaction w/ full warranty**	(3) Standard deviation	(4) **Interaction w/ three installment**	(4) Standard deviation
SHS price in 1000 Pakistani Rs	-0.021**		-0.021**		-0.022**		-0.021**	
	(0.010)		(0.010)		(0.010)		(0.010)	
HH head age interaction	0.000		-0.001		0.001		-0.007*	
	(0.005)		(0.004)		(0.005)		(0.004)	
HH head education years interaction	-0.014		0.003		0.030		0.019	
	(0.025)		(0.025)		(0.035)		(0.028)	
HH head literacy interaction	-0.077		-0.122		-0.089		-0.074	
	(0.243)		(0.231)		(0.288)		(0.231)	
No. of HH members interaction	0.030*		0.006		0.023*		0.007	
	(0.017)		(0.012)		(0.014)		(0.013)	
Monthly HH expenses interaction	0.001		0.003		0.004		-0.007***	
	(0.003)		(0.002)		(0.003)		(0.003)	
Health scale interaction	0.003		-0.013		-0.000		0.017	
	(0.062)		(0.046)		(0.061)		(0.045)	
Electricity attitude interaction	0.181***		0.140**		0.066		-0.078	
	(0.061)		(0.059)		(0.076)		(0.076)	
Solar attitude interaction	0.080		0.136		0.068		0.110	
	(0.091)		(0.089)		(0.099)		(0.094)	
NEP interaction	-0.356***		0.028		0.137*		-0.051	
	(0.090)		(0.077)		(0.076)		(0.073)	
Life satisfaction interaction	-0.007		0.030		0.063		-0.040	
	(0.064)		(0.051)		(0.066)		(0.069)	
IFC label	0.610**	0.944***	0.761***	1.002***	0.764***	1.008***	0.763***	1.000***
	(0.308)	(0.091)	(0.081)	(0.094)	(0.082)	(0.093)	(0.081)	(0.094)
SVTC label	0.563***	0.654***	-0.041	0.621***	0.564***	0.662***	0.562***	0.649***
	(0.057)	(0.089)	(0.302)	(0.093)	(0.058)	(0.089)	(0.058)	(0.089)
Six months warranty	0.722***		0.722***		0.717***		0.720***	
	(0.064)		(0.063)		(0.063)		(0.064)	
One year warranty	1.247***		1.246***		0.360		1.250***	
	(0.071)		(0.071)		(0.346)		(0.071)	
Two installment payments	0.490***		0.489***		0.493***		0.490***	
	(0.050)		(0.051)		(0.051)		(0.051)	
Three installment payments	0.535***		0.535***		0.537***		0.990***	
	(0.071)		(0.072)		(0.071)		(0.286)	
n	13,023	13,023	13,023	13,023	13,023	13,023	13,023	13,023
Video treatment included	NO	NO	NO	NO	NO	NO	YES	YES

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with socioeconomic indicator variables and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the preference space. The basis for the estimation is the DCE with n=792 participants and six choice sets per respondent. Robust standard errors clustered at the village level in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

TABLE D.A5 – Respondent Characteristics and SHS Preferences Without Video Treatment (Latent Class Logit Models)

VARIABLES	(1) Choice Class 1	(2) Choice Class 2	(3) Class 1 Member	(4) Choice Class 1	(5) Choice Class 2	(6) Choice Class 3	(7) Class 1 Member	(8) Class 2 Member
SHS price in 1000 Pakistani Rs	-0.091***	0.005		0.036***	-0.293***	-0.057***		
	(0.012)	(0.007)		(0.008)	(0.047)	(0.015)		
IFC label	2.298***	0.051		0.040	1.096***	2.638***		
	(0.192)	(0.062)		(0.064)	(0.254)	(0.210)		
SVTC label	1.444***	0.153***		0.193***	0.181	1.774***		
	(0.144)	(0.056)		(0.063)	(0.227)	(0.167)		
Six months warranty	2.051***	0.305***		0.280***	1.097***	2.344***		
	(0.188)	(0.081)		(0.089)	(0.221)	(0.220)		
One year warranty	2.915***	0.618***		0.598***	1.767***	3.288***		
	(0.221)	(0.083)		(0.088)	(0.252)	(0.259)		
Two installment payments	0.526***	0.385***		0.296***	1.331***	0.354**		
	(0.117)	(0.072)		(0.076)	(0.294)	(0.142)		
Three installment payments	0.436***	0.552***		0.406***	1.875***	0.266*		
	(0.125)	(0.070)		(0.081)	(0.308)	(0.137)		
Class Share			0.442				0.471	0.171
HH head age			0.003				-0.001	-0.028*
			(0.009)				(0.009)	(0.015)
HH head education years			0.009				-0.008	0.040
			(0.055)				(0.059)	(0.107)
HH head literacy			-0.500				0.525	-0.780
			(0.446)				(0.478)	(0.849)
No. of HH members			0.046*				-0.045*	-0.001
			(0.025)				(0.027)	(0.042)
Monthly HH expenses			0.005				-0.005	-0.044**
			(0.005)				(0.005)	(0.018)
Health scale			0.128				-0.111	0.201
			(0.107)				(0.113)	(0.203)
Electricity attitude			0.568***				-0.583***	-0.218
			(0.167)				(0.177)	(0.264)
Solar attitude			0.724**				-0.976***	-0.209
			(0.287)				(0.337)	(0.469)
Life satisfaction			-0.033				0.040	-0.192
			(0.114)				(0.127)	(0.176)
NEP			-0.388***				0.501***	-0.328
			(0.143)				(0.166)	(0.201)
Constant			-2.601***				2.793***	2.727**
			(0.744)				(0.835)	(1.166)
n	13,023	13,023	13,023	13,023	13,023	13,023	13,023	13,023
Video included	NO	NO	NO	NO	NO	NO	NO	NO

Note: Expectation-Maximization Maximum-Likelihood estimation using the user-written Stata module *lclogit* (Pacifico & Yoo, 2013) with $Q = 2$ and $Q = 3$ respondent classes. Estimation results given in this table are based on a total of six choice sets per respondent. The upper part of the table reports fixed parameter estimates for the respective investor classes. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 based on z-statistics.

Table D.A6 – Summary Statistics on SHS Experience Indicator Variables

VARIABLES	n	mean	sd	min	max
Household was provided with SHS in SCCDP	1,182	0.497	0.500	0	1
Household currently owns a SHS	1,182	0.209	0.407	0	1
SCCDP subsample only (n = 587)					
SHS not in use due to malfunction	587	0.497	0.500	0	1
Stated full satisfaction with current SHS	587	0.184	0.388	0	1

Table D.A7 – Heterogenous Experiences with SHS in WTP Space without Video Treatment (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

	(1)		(2)		(3)		(4)	
VARIABLES	**Interaction w/ SCCDP**	Standard deviation	**Interaction w/ Current Solar**	Standard deviation	**Interaction w/ Solar malfunction**	Standard deviation	**Interaction w/ Solar satisfied**	Standard deviation
SHS price in 1000 Pakistani Rs	-3.467***	1.306***	-3.475***	1.256***	-3.537***	1.678***	-3.795***	1.495***
	(0.139)	(0.105)	(0.142)	(0.103)	(0.144)	(0.202)	(0.222)	(0.161)
LG Label interaction	7.347**		13.549***		-18.349***		57.427***	
	(3.717)		(4.931)		(3.241)		(15.455)	
SVTC label interaction	4.591*		13.630***		-14.340***		33.096***	
	(2.624)		(3.793)		(2.637)		(9.743)	
Six months warranty interaction	10.696**		16.078**		-9.697**		34.855***	
	(4.480)		(6.251)		(4.526)		(13.156)	
One year warranty interaction	9.974**		18.316***		-22.466***		49.804***	
	(5.048)		(6.997)		(5.281)		(18.484)	
Two installment payments interaction	1.813		-2.159		5.164*		-17.347**	
	(3.021)		(3.742)		(2.646)		(7.720)	
Three installment payments interaction	4.592		-2.815		8.859***		-16.026**	
	(3.071)		(3.051)		(2.362)		(7.379)	
LG label	20.983***	19.896***	22.621***	20.564***	39.832***	19.052***	30.144***	-20.461***
	(3.340)	(3.370)	(3.382)	(3.458)	(4.621)	(1.819)	(6.217)	(4.563)
SVTC label	13.890***	-10.992***	13.854***	-9.841***	25.960***	-11.254***	21.162***	-11.901***
	(2.444)	(1.898)	(2.394)	(2.420)	(3.159)	(1.706)	(4.854)	(2.465)
Six months warranty	18.058***		21.240***		35.949***		36.605***	
	(3.470)		(3.501)		(4.703)		(8.365)	
One year warranty	33.914***		36.486***		55.810***		53.237***	
	(5.216)		(5.531)		(6.909)		(11.953)	
Two installment payments	11.016***		12.649***		10.883***		20.700***	
	(2.228)		(2.340)		(2.262)		(5.322)	
Three installment payments	10.489***		13.697***		11.112***		26.115***	
	(1.916)		(2.611)		(1.539)		(6.701)	
n	14,190	14,190	14,190	14,190	7,743	7,743	7,743	7,743
Video treatment included	NO	NO	NO	NO	NO	NO	NO	NO

*Note***:** Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with indicator variables for heterogenous experiences with solar electrification and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n = 792 participants and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A8 – Heterogenous Experiences with SHS in Preference Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

VARIABLES	(1) **Interaction w/ SCCDP**	Standard deviation	(2) **Interaction w/ Current Solar**	Standard deviation	(3) **Interaction w/ Solar malfunction**	Standard deviation	(4) **Interaction w/ Solar satisfied**	Standard deviation
SHS price in 1000 Pakistani Rs	-0.041***		-0.041***		-0.028*		-0.028*	
	(0.010)		(0.010)		(0.014)		(0.014)	
LG Label interaction	0.073		0.293**		-0.578***		0.728***	
	(0.115)		(0.132)		(0.136)		(0.195)	
SVTC label interaction	0.146		0.396***		-0.413***		0.575***	
	(0.093)		(0.115)		(0.129)		(0.156)	
Six months warranty interaction	0.110		0.406***		-0.529***		0.519**	
	(0.108)		(0.152)		(0.151)		(0.241)	
One year warranty interaction	0.209*		0.475***		-0.776***		0.622***	
	(0.109)		(0.132)		(0.196)		(0.202)	
Two installment payments interaction	-0.183**		-0.077		0.008		-0.501***	
	(0.093)		(0.111)		(0.145)		(0.190)	
Three installment payments interaction	-0.036		-0.000		0.003		-0.269	
	(0.106)		(0.122)		(0.161)		(0.225)	
LG label	0.677***	0.991***	0.658***	0.984***	1.051***	0.971***	0.626***	0.963***
	(0.085)	(0.077)	(0.068)	(0.075)	(0.122)	(0.114)	(0.082)	(0.106)
SVTC label	0.466***	0.729***	0.454***	0.724***	0.818***	0.656***	0.511***	0.648***
	(0.065)	(0.071)	(0.046)	(0.071)	(0.111)	(0.088)	(0.063)	(0.088)
Six months warranty	0.628***		0.605***		1.024***		0.660***	
	(0.082)		(0.060)		(0.095)		(0.079)	
One year warranty	1.133***		1.145***		1.772***		1.266***	
	(0.076)		(0.063)		(0.138)		(0.093)	
Two installment payments	0.669***		0.595***		0.490***		0.564***	
	(0.057)		(0.046)		(0.117)		(0.068)	
Three installment payments	0.673***		0.657***		0.657***		0.695***	
	(0.071)		(0.060)		(0.092)		(0.086)	
n	21,144	21,144	21,144	21,144	10,497	10,497	10,497	10,497
Video treatment included	YES	YES	YES	YES	YES	YES	YES	YES

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect preference interaction with indicator variables for heterogenous experiences with solar electrification and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the preference space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Robust standard errors clustered at the village level in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A9 – Awareness Video Treatment in WTP Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

VARIABLES	(1) Full Sample	Standard deviation	(2) Video Treatment Only	Standard deviation
ifc x video	-6.233***			
	(2.096)			
svtc x video	-3.151*			
	(1.631)			
medium warranty x video	-7.521***			
	(2.780)			
high warranty x video	-7.054**			
	(2.839)			
two installments x video	-0.555			
	(1.646)			
three installments x video	0.936			
	(1.752)			
ifc x ifc video			-9.062***	
			(2.888)	
svtc x ifc video			-5.603**	
			(2.451)	
medium warranty x ifc video			-8.072**	
			(3.291)	
high warranty x ifc video			-18.454***	
			(3.960)	
two installments x ifc video			4.303	
			(2.736)	
three installments x ifc video			3.613*	
			(2.194)	
ifc x svtc video			-10.637***	
			(2.856)	
svtc x svtc video			-5.314**	
			(2.438)	
medium warranty x svtc video			-5.006	
			(3.275)	
high warranty x svtc video			-12.894***	
			(3.897)	
two installments x svtc video			6.454**	
			(2.669)	
three installments x svtc video			6.683***	
			(2.116)	
SHS price in 1000 Pakistani Rs	-3.104***	1.219***	-2.375***	1.163***
	(0.084)	(0.081)	(0.105)	(0.140)
LG label	19.118***	16.862***	15.916***	9.215***
	(1.638)	(1.845)	(2.658)	(1.058)
SVTC label	12.925***	8.982***	10.085***	-8.150***
	(1.267)	(1.203)	(2.223)	(0.870)
Six months warranty	18.326***		12.508***	
	(2.327)		(2.992)	
One year warranty	29.815***		25.583***	
	(2.637)		(3.807)	
Two installment payments	9.634***		1.938	
	(1.099)		(2.493)	
Three installment payments	10.329***		4.411**	
	(1.301)		(1.820)	
Observations	21,126	21,126	6,954	6,954

Note: Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect interaction with indicator variables for video treatments and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the WTP space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Standard errors in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A10 – Awareness Video Treatment in Preference Space (Stochastic Maximum Likelihood Estimation in a Mixed Logit Model)

VARIABLES	(1) Full Sample	Standard deviation	(2) Video Treatment Only	Standard deviation
ifc x video	-0.169			
	(0.107)			
svtc x video	-0.070			
	(0.084)			
medium warranty x video	-0.180*			
	(0.099)			
high warranty x video	-0.016			
	(0.108)			
two installments x video	0.154			
	(0.098)			
three installments x video	0.249**			
	(0.125)			
ifc x ifc video			-0.456*	
			(0.253)	
svtc x ifc video			-0.214	
			(0.256)	
medium warranty x ifc video			-0.059	
			(0.292)	
high warranty x ifc video			-0.853***	
			(0.296)	
two installments x ifc video			0.332	
			(0.207)	
three installments x ifc video			0.448*	
			(0.248)	
lg x svtc video			-0.570**	
			(0.252)	
svtc x svtc video			-0.102	
			(0.204)	
medium warranty x svtc video			0.119	
			(0.245)	
high warranty x svtc video			-0.382	
			(0.247)	
two installments x svtc video			0.500**	
			(0.213)	
three installments x svtc video			0.751***	
			(0.220)	
SHS price in 1000 Pakistani Rs	-0.041***		-0.077***	
	(0.010)		(0.013)	
LG label	0.774***	0.991***	1.026***	1.026***
	(0.080)	(0.076)	(0.211)	(0.125)
SVTC label	0.559***	0.744***	0.633***	0.898***
	(0.055)	(0.073)	(0.182)	(0.106)
Six months warranty	0.742***		0.586***	
	(0.062)		(0.205)	
One year warranty	1.242***		1.654***	
	(0.075)		(0.207)	
Two installment payments	0.530***		0.386**	
	(0.047)		(0.179)	
Three installment payments	0.570***		0.376**	
	(0.068)		(0.180)	
Observations	21,126	21,126	6,954	6,954

*Note***:** Dependent variable: binary choice indicator for respective SHS in choice set. Explanatory interaction terms and dummy variables reflect interaction with indicator variables for video treatments and preferences for attribute levels respectively. 1000 Halton draws were used for the mixed logit estimation in the preference space. The basis for the estimation is the DCE with n=1,182 participants and six choice sets per respondent. Robust standard errors clustered at the village level in parentheses. p-values: *** < 0.01, ** < 0.05, * < 0.1.

Table D.A11 – Socioeconomic Differences between Households with and without Urdu Proficiency

	No Urdu			Urdu			
VARIABLES	n	mean	sd	n	mean	sd	difference no Urdu – Urdu
age of hh head	793	45.29	11.48	389	43.99	11.42	-1.302*
hh head years of education	793	1.55	3.37	389	3.43	4.34	1.878***
hh head able to read and/or write?	793	0.21	0.41	388	0.50	0.50	0.286***
no. of people living in hh	793	8.53	4.08	389	8.83	4.04	0.298
monthly hh expenses (in 1,000 PRs)	793	23.62	20.70	389	23.18	16.83	-0.440
stated hh health assessment	793	1.06	1.10	389	1.22	0.90	0.168***
"communities can benefit from electricity"	781	1.56	0.87	384	1.80	0.65	0.236***
"solar system is good source of electricity"	790	1.79	0.58	388	1.88	0.43	0.086***
NEP	792	1.21	1.01	388	1.43	0.84	0.216***
stated overall life satisfaction	737	1.48	0.72	364	1.44	0.71	-0.048

D.B – Experimental Protocol

Choice Experiment – Sindh Coastal Regions

(please read all of this aloud to the respondent)

(مدعا کو یہ سب بلند آواز سے پڑھیں)

For this part of the survey, I would like you to imagine the following situation: you are heading out to your trusted vendor of solar products on the local market and you are looking to purchase a new solar home system (complete setup with panel, battery and charge controller) for your household.

سروے کے اس حصے کے ل I ، میں آپ سے درج ذیل صورتحال کا تصور کرنا چاہوں گا: آپ مقامی مارکیٹ میں شمسی توانائی سے متعلق مصنوعات کے اپنے قابل اعتماد وینڈر کی طرف جارہے ہیں اور آپ ایک نیا سولر ہوم سسٹم (پینل ، بیٹری کے ساتھ مکمل سیٹ اپ) خریدنے کے خواہاں ہیں۔ اور چارج کنٹرولر) اپنے گھر والوں کے لئے۔

The solar home system you are looking to purchase consists of the following components:

- A **170 W poly crystalline "German/Germancell" solar panel**
- A **12 V 100 Amp battery** to store electric energy generated from the solar panel
- A **charge controller** to protect your battery from overcharging, which ensures a longer battery lifetime

سولر ہوم سسٹم جس کی آپ خریداری کے لئے تلاش کر رہے ہیں ان میں مندرجہ ذیل اجزاء شامل ہیں:

- ایک 170 ڈبلیو پولی کرسٹل "جرمن / جرمینل" شمسی پینل

- شمسی پینل سے پیدا ہونے والی برقی توانائی کو ذخیرہ کرنے کے لئے ایک 12 V 100 Amp بیٹری

- آپ کی بیٹری کو زیادہ چارجنگ سے بچانے کے لئے ایک چارج کنٹرولر ، جو لمبی عمر میں بیٹری کو یقینی بناتا ہے

I would like you to imagine that your vendor, according to your wishes stated above, offers you three alternative products. All products feature the exact technical specifications listed above; however, they differ with regards to the following attributes:

میں آپ کو یہ تصور کرنا چاہوں گا کہ آپ کا دکاندار ، مذکورہ بالا آپ کی خواہشات کے مطابق ، آپ کو تین متبادل مصنوعات پیش کرتا ہے۔ تمام مصنوعات میں مندرجہ بالا تکنیکی خصوصیات کی عین مطابق خصوصیات پیش کی گئی ہیں۔ تاہم ، وہ مندرجہ ذیل صفات کے حوالے سے مختلف ہیں:

- The **IFC Lighting Global certification** (for information, show card below)

- آئی ایف سی لائٹنگ گلوبل سرٹیفیکیشن (معلومات کے لئے ، ذیل میں کارڈ دکھائیں)

- An additional **product/material warranty** against product malfunctioning e.g. from manufacturing defects (panel, battery and controller) ranging from 0 to 1 year

- مصنوعات کی خرابی کے خلاف ایک اضافی مصنوع / مواد کی وارنٹی جیسے۔ 0 سے 1 سال تک کے مینوفیکچرنگ نقائص (پینل ، بیٹری اور کنٹرولر) سے

- The **Solar Scorecard certification** (for information, show card below)

- شمسی اسکور کارڈ کی سند (معلومات کے لئے ، ذیل میں کارڈ دکھائیں)

- Different **payment options** (ranging from direct cash payments to installments over 1-2 years)

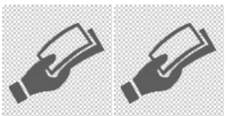
- ادائیگی کے مختلف اختیارات (براہ راست نقد ادائیگی سے لے کر قسطوں تک 1-2 سال تک)

- Direct one-time payment:

- براہ راست ایک وقت کی ادائیگی:

- Two installments (first payment on purchase and second after six months):

- دو قسطیں (خریداری پر پہلی ادائیگی اور چھ ماہ کے بعد دوسری):



- Three installments (first payment on purchase, second after six months, third after one year):

- تین قسطیں (خریداری پر پہلی ادائیگی ، چھ ماہ کے بعد دوسری ، ایک سال کے بعد تیسری):

- 

- The setup’s total product’s **price** ranging between **Rs. 14.000 and Rs. 26.000**

- سسٹم کی مجموعی مصنوعات کی قیمت Rs Rs سے... روپے تک ہے 14.000 اور روپے 26.000

Rs. 14.000 – 26.000

Please take a look at the following card, which illustrates one of the choice situations we will ask you to evaluate. We will call this a choice card from hereon.

(Let the respondent take a look at the example card below)

In the following we will ask you to evaluate a total of 6 of these choice situations and choose your most preferred option. Please choose honestly and according to your real preference. Of course, your answers will be treated anonymously and confidentially.

براہ کرم مندرجہ ذیل کارڈ پر ایک نظر ڈالیں ، جو ان انتخابی صورتحال میں سے ایک کی مثال پیش کرتا ہے جو ہم آپ سے اندازہ کرنے کے لئے کہیں گے۔ ہم اس کو یہاں سے کسی انتخاب کا کارڈ کہیں گے۔

(جواب دہندگان کو نیچے دیئے گئے مثال کے کارڈ پر ایک نظر ڈالیں)

مندرجہ ذیل میں ہم آپ سے کل ان 6 انتخابی حالات کا جائزہ لینے اور اپنے پسندیدہ انتخاب کا انتخاب کرنے کے لئے کہیں گے۔ براہ کرم ایمانداری اور اپنی اصل ترجیح کے مطابق انتخاب کریں۔ یقینا ، آپ کے جوابات کا استعمال گمنام اور خفیہ طور پر کیا جائے گا۔

Example Choice Card:

Product 1	Product 2	Product 3	None
LIGHTING GLOBAL Catalyzing markets for modern off-grid energy	-	LIGHTING GLOBAL Catalyzing markets for modern off-grid energy	-
-	EXTENDED 1 YEARS WARRANTY	6 MONTHS WARRANTY	-
SVTC SILICON VALLEY TOXICS COALITION	-	-	-
			-
Rs. 18,000	**Rs. 22,000**	**Rs. 14,000**	-
○	○	○	○

Did you understand all of the information or is there anything you would like to ask or clarify with me?

(Wait for respondent's answer and answer all questions to your best knowledge)

Then I would like to start with handing you the first choice-card now.

*(Now show the cards from the current set **in order** and enter the according information on choice set number and chosen products in the survey form on your smart device)*

کیا آپ کو ساری معلومات سمجھ گئی ہیں یا کوئی ایسی چیز ہے جس کے بارے میں آپ مجھ سے پوچھنا یا وضاحت کرنا چاہیں گے؟

(جواب دہندگان کے جواب کا انتظار کریں اور اپنے سوالات کے جوابات تمام بہتر جوابات دیں)

تب میں آپ کو پہلے انتخاب کا کارڈ حوالے کرنے کے ساتھ شروع کرنا چاہتا ہوں۔

(اب موجودہ سیٹ میں سے کارڈز کو ترتیب سے دکھائیں اور اپنے سمارٹ آلہ پر سروے کے فارم میں انتخاب سیٹ نمبر اور منتخب کردہ مصنوعات سے متعلق معلومات درج کریں)

THE IFC LIGHTING GLOBAL CERTIFICATION

The IFC Lighting Global Certification goes even beyond regular ISO9000 and IEC certifications and is issued only to solar products that ensure baseline quality standards on:

- High build quality and durability of the product and all its components, including the battery.
- Truth in advertising regarding the product, its components and their functionality. This includes user manuals, and accurate information regarding technical specifications and replacement methods of the product.
- Maintenance that includes battery protection and battery durability.
- Health and safety measures which ensure overload and electrocution protection.

آئی ایف سی لائٹنگ گلوبل سرٹیفیکیشن

آئی ایف سی لائٹنگ گلوبل سرٹیفیکیشن باقاعدہ آئی ایس او 9000 اور آئی ای سی سرٹیفیکیشن کی پائداری کے معیار سے بھی آگے ہے اور صرف شمسی مصنوعات کو جاری کیا جاتا ہے جو مندرجہ ذیل معیارات کو یقینی بناتی ہیں :

- سولر ہوم سسٹم کے تمام اجزاء بشمول بیٹری کے اعلی تعمیراتی معیار اور استحکام۔
- مصنوعات ، اجزاء اور ان کی فعالیت سے متعلق اشتہارات میں سچائی ۔ اس میں صارف کے دستورالعمل ، مصنوعی وضاحتیں اور مصنوع کے متبادل طریقوں سے متعلق درست معلومات شامل ہیں۔
- دیکھ بھال جس میں بیٹری کی حفاظت اور بیٹری کا استحکام شامل ہوں۔
- صحت اور حفاظت کا اقدام جو اوورلوڈ اور بجلی سے بچاؤ کو یقینی بناتے ہیں۔

THE SOLAR SCORECARD CERTIFICATE

The SOLAR SCORECARD CERTIFICATE by the Silicon Valley Toxics Coalition (SVTC) is issued only to solar products of manufacturers that put special emphasis on:

- Reducing emissions in solar panel production.
- Reducing the use of toxic chemicals, minerals and heavy metals in solar panel production.
- Reducing the amount of water and electricity used in solar panel production.
- Recycling as many materials as possible in production and ensuring an easy recyclability of the end product.

شمسی اسکور کارڈ کا سرٹیفکیٹ

سلیکن ویلی ٹوکسکس کولیشن (ایس وی ٹی سی) کے ذریعے شمسی اسکور کارڈ کا سرٹیفکیٹ صرف ان مینوفیکچررز کی شمسی مصنوعات کو جاری کیا جاتا ہے جو مندرجہ:ذیل خصوصیات پر زور دیتے ہیں :

- شمسی پینل کی تیاری میں زہریلے اخراج کو کم کرنا۔
- شمسی پینل کی تیاری میں زہریلے کیمیکلز ، معدنیات اور بھاری دھاتوں کے استعمال کو کم کرنا۔
- شمسی پینل کی تیاری میں استعمال ہونے والے پانی اور بجلی کی مقدار کو کم کرنا۔
- پیداوار میں زیادہ سے زیادہ مادوں کی ر یسائیکلنگ اور اختتام مصنوع کی آسان ریسائیکلنگ کو یقینی بنانا۔

D.C – Treatment Video Scripts and Screenshots

SUFI Choice Experiment Treatment Video "Script"- With Urdu translation

Parts in blue only in quality/durability treatment video

- This information is expected to directly and exclusively affect hypothetically stated user preferences for the attribute "IFC Lighting Global Label" (see https://www.lightingglobal.org/quality-assurance-program/our-standards/).

Parts in green only in environmental treatment video

- This information is expected to directly and exclusively affect hypothetically stated user preferences for the attribute "SolarScore Label" (based on criteria from the SolarScorecard initiative: http://www.solarscorecard.com/2014/2014-SVTC-Solar-Scorecard.pdf)

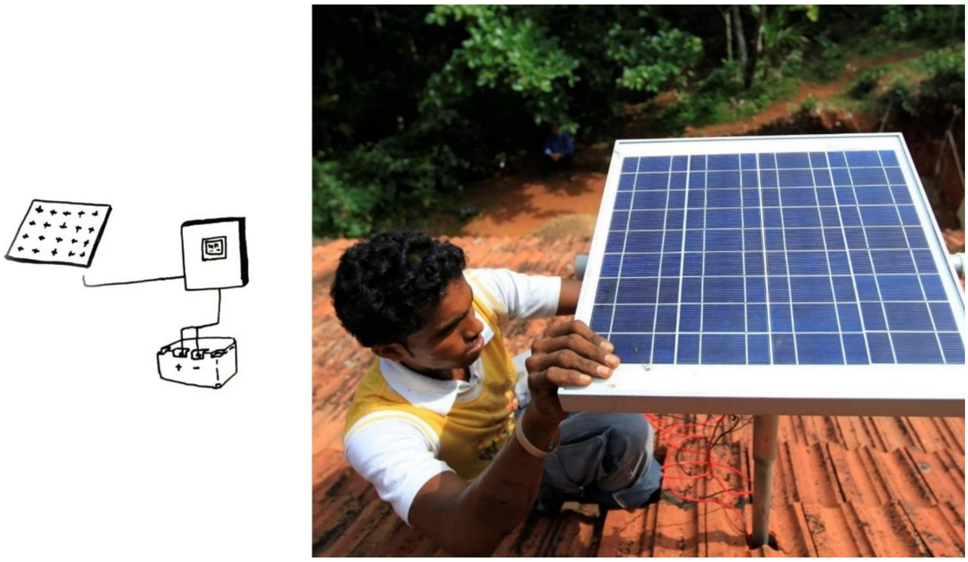
Narrator:

1. Solar home systems are stand-alone photovoltaic systems.	1. Solar home systems enfiradi photovoltaic systems hain.
2. They offer a cost-effective and convenient mode of supplying power for lighting and appliances.	2. Ye bijli faraham karne ka ek mufeed aur asaan hul hai, jis se light aur deegar appliances istemaal kiye ja saktay hain.
3. Employing such systems can be interesting for rural households without connection to grid electricity.	3. Ye bijli ki farahmi ka ek dilchasp tareeqa hai, khaas toar par un gharou kay liye jahan grid se bijli mayassir nahi.
4. But they can also be worthwhile for urban or peri-urban households, who suffer from frequent blackouts or load-shedding.	4. Bijli faraham kerne ka ye tareeqa un baray shehroun ya shehri ilaqoun kay liye bhi mufeed hai jahan bijli honay kay bawujood bijli janay aur load shedding ka silsila musalsal jari rehta hai.
5. A typical solar home system consists of a solar panel, a battery and a charge controller.	5. Solar Home System main ek solar panel (jis se soorj ki shuaon se bijli

	paida hoti hai), ek battery (jis mai solar panel se bannay wali bijli jama hoti hai) aur ek charge controller aam taor per shamil hota hai.
6. The charge controller distributes the electric power generated from the panel to the battery or directly to the desired appliance and prevents them from damage.	6. Charge controller na sirf solar panel se paida honay wali bijli, battery ya phir barah-e-raast appliances ko taqseem kerne ka kaam anjaam deta hai balkay en dono ko zaroorat se zyada charge honay k nuksaan se bhi bachata hai.
7. Electric energy can be stored in the battery for times when the sun is not shining.	7. Battery mai mehfooz bijli, sooraj ghuroob hooney kay baad, bijli ki zaroorat ko poora karne mai madad kerti hai.
8. A solar home system can increase the standard of living for both rural and urban households in various ways:	8. Solar Home Systems, gaon aur shehri elaqoun main in wajohaat ki wajha sey mayaar-e-zindagi main behtari la saktey haain.
9. By providing grid-independent electric energy, it enables households to provide energy for lighting, as well as information and communication devices such as TVs and mobile phones irrespective of blackouts or load-shedding.	9. Enfiradi toar pe bijli kay connection, light ki farahmi, muvaslaat aur, mobile phone aur TV jese alaat k liye, bawujood bijli munqatah honay k, Solar Home Systems kay zariye se bijli ki farahmi ko yaqeeni banaya ja sakta hai.
10. Solar home systems can also make rural households independent from smoke-emitting lighting devices which are known to cause respiratory diseases.	10. Gaon main wo ghar jahan light ki farahmi kay liye mitti k tael aur deegar dhuwan paida kerne walay alaat istemaal kiye jatay hain, wahan Solar Home Systems k zariye se saans ki takleef ya doosri beemarion se bhi bacha ja sakta hai.
11. Even for households with a grid electricity connection, a solar home system can be a worthwhile investment, as it can be used to power basic appliances, thereby reducing the utility bill.	11. Mazeed ye k, woh ghar ya elaqay jahan bijli ki sahulat mayassar hai, wahan per bhi, Solar Home Systems kay estemaal kay zariye bijli kay bilou main kami lai ja sakti hai.
12. However, the quality of solar home systems typically offered in urban and	12. Lekin gaon ~~ya~~ aur shehri elaqoun keh bazaaron main bikne walay ye Solar

rural marketplaces strongly varies with regards to different aspects of the product.	Home Systems kay ashia keh mayar mein kaafi faraq hota hai.
13. Therefore, quality certificates play an increasingly large role in the market for solar home systems.	13. Issi wajah se, Solar Home Systems kay khareed-o-farokht kay liye ma'ayari tasdeeq, yani quality certificates ek ehem kirdar ada kertay hain.
14. One good example is the certificate by the World Bank's Lighting Global initiative, which is only issued if the solar home system in question fulfils various quality standards with regards to durability, safety and truthful advertising.	14. Misaal k toar per World Bank ka Lighting Global Initiative ka faraham kerda ma'ayari tasdeeq (certificate), Solar Home Sytems ki mazbooti, hifazati iqdamat aur ishtehaari sadaqat ko madde-nazar rakhte huay diya jata hai.
15. This certificate guarantees a high manufacturing quality with regards to the panels themselves, but also the batteries and wiring that come with it.	15. Ye certificate Solar Home Systems (ba'shamool solar panels, battery, taar aur deegar samaan) kay a'ala ma'ayar ki zamanat deta hai.
16. Therefore, buyers of products with the IFC certificate can be sure that they are purchasing a system with a high overall durability that will not need repairs or even replacement already after a relatively short service life.	16. Leyhaza, IFC certificate ki zamanat walay masnoo'aat kay khareedar, en masnoo'aat ki mazbooti aur ek taveel muddat tak murramat aur tabdeeli ki pareshanion se bachao ki yaqeen deyhani ker saktay hain.
17. The certificate also safeguards truthful advertising of the product with regards to the technological specifications of the product and safety issues relating to the electric current or liquids within the battery.	17. Ye certificate bijli se khatraat, bijli k jhatkay waghera aur battery main moujood mavaad se muta'liq hifazati iqdamaat aur deegar takneeki ma'loomat aur tafseelaat ki zamanat deta hai.
18. Another aspect of using a solar home system over other sources of electricity is their positive contribution towards environmental sustainability.	18. Solar Home Systems kay istemaal ka ek pehlu ye bi hai kay ye mahauliya'ati satah pe musbat tareeqay se asar andaaz hotay hain.
19. This is because these systems do not emit any greenhouse gases during electricity generation, while conventional energy sources like grid electricity or diesel generators do so a lot.	19. Es ki ek wajah ye hai k generator ya grid connection kay muqablay, Solar Home Systems se ban'nay wali bijli ki paeda waar mai Greenhouse gases (yani?? zehreela dhuwaan) khaarij nahi hota.
20. However, the positive environmental impact of solar home systems can	

potentially be undermined by several factors.	20. Magar kayi wajoohat ki bina per, ess k zahiri musbat asaraat main kami rehti hai.
21. Initiatives like the Solar Scorecard try to establish a certificate for solar products to enable consumers to differentiate environmental-friendly solar products from others.	21. Solar Scorecard ek aesa iqdaam hai jis kay diye gaye certificate ki madad se sahi (mahauliya'ati toar pe musbat) aur nuqsan deh systems mai farq kernay main asani paeda hosakti hai.
22. The production of solar panels requires acids, as well as large amounts of water and electricity and creates waste.	22. Solar panels ko bana nay k liye taizaab istemaal kia jata hai, ek bari miqdaar main bijli aur pani kharch hota hai aur kayi aur wasaa'el istemaal main zaya hojatay hain.
23. The Solar Scorecard certificate is only issued to manufacturers of solar panels who take large care to use few resources and create minimal waste in their production processes instead of opting for cheaper and quicker, but also more hazardous production processes.	23. Solar Scorecard certificate, un solar panels bananay walou ko diya jata hai jo wasa'el ka mo'assar istemaal kertay hain, bajaye un kay jo apnay masnoo'aat k ma'yaar main aur un ko bana nay kay amal mai sasti aur nuqsaan pohchane wali cheezein istemal kartey haain.
24. The Solar Scorecard certificate also indicates that the manufacturer of the solar product took care to ensure that the product is easily recyclable after its service life to prevent additional environmental hazards.	24. Solar Scorecard certificate ess baat ki bhi nishandahi kerta hai kay ye masnoo'aat muddat-istemaal kay baad ba'asani recycle kiye ja saktay hai ta keh mauhaliyat ko aur ziada nuqsaan na pohanchey.



Description of technological SHS setup

Description of health benefits over traditional lighting sources

Lighting Global label description

SVTC Solar Scorecard related description of environmental damages associated to solar panel production

Appendix E (Chapter 6)

E.A – Additional Case Study Information

E.A.A - CBNRM in Namibia

For much of the twentieth century, the colonial state of South Africa was responsible for the management of its territory's wildlife, resulting in the exclusion and marginalization of local people through the establishment of national parks and the allocation of the best farmland to white commercial farmers. Following Namibia's independence in 1990 and supported by political processes such as the Rio Declaration of 1992 accentuating inclusive participation (Schnegg & Linke, 2016), the common pool resource theory inspired by Ostrom's (1990) design principles (Roe & Nelson, 2009) and the positive experiences of other southern African countries with CBNRM, development agents in Namibia were informed and educated about the potential benefits of devolving natural resources to local communities, thereby integrating the conservation of natural resources into the process of rural development (Boudreaux & Nelson, 2011). By means of harnessing income opportunities from the joint management of natural resources (e.g., through the establishment of tourism and hunting enterprises), it was assumed that CBNRM would provide financial conservation incentives for local communities, creating a potential win-win situation for both the local people and the environment (Barnes et al., 2002). Especially during the initiation phase of CBNRM projects, local communities often received financial and technical support in order to create sustainable income opportunities from natural resources and sustainably manage the wildlife population in cooperation with the responsible government ministry (Boudreaux & Nelson, 2011).

After a series of preliminary policies and legislation devolving wildlife management rights to local communities in the early 1990s, the Namibian government adopted the National Conservation Amendment Act in 1996, which commenced official efforts to establish an extensive CBNRM program on a country-wide scale. Today, local communities are entitled to register as conservancies under the administration of the Namibian Association of CBNRM Support Organisations (NACSO). For approval, a specific set of requirements must be met: communities must predefine and agree on the conservancy border, identify permanent members who will organize and attend regular meetings, declare a constitution containing strategies concerning wildlife management and benefit distribution and report to the conservancy members and NACSO on a regular basis.

At present, 86 conservancies have been established on Namibian communal lands; in addition, there are 32 registered community forests and two community fish reserves, which operate in a manner similar to the conservancies. These three types of CBNRM cover a total area of 166,045 km2, amounting to 52.9% of all communal land in Namibia. With respect to the main goals of the program – alleviating rural poverty and putting a halt to the sharp decrease in wildlife populations – the Namibian CBNRM program appears to be a success story: between the first community conservation efforts on Namibian soil in 1990 and 2016, the program has contributed more than 5.9 billion NAD (937 million US$ PPP) to the Namibian net national income. The last two decades have seen constantly increasing annual returns for community conservation in Namibia, resulting in the generation of more than 111 million NAD (18 million US$ PPP) in returns for local communities in 2016 alone. With regard to wildlife, Namibia's elephant population tripled between 1995 and 2016, a trend that is reflected in the total figures for other animals as well (NACSO, 2018, p. 13).

However, although some conservancies have successfully developed income sources from tourism or hunting, substantial economic benefits have not materialized for the majority of conservancies. In fact, as of 2017, 15 (18%) officially registered conservancies generate no cash income at all and 45 (54%) are unable to fully cover their operating costs; only 38 (45%) are directly involved in any tourism activities (NACSO, 2018, pp. 56, 65). Such activities include both lodges and simple campsites, obviously with very different effects on revenues. These conservancies are mainly clustered in the Kunene and Erongo regions in the northwestern part of the country or within the Zambezi region in the far northeast, home to some of the most popular tourist destinations. The financial difficulties of more remote conservancies may be aggravated in the future if external agencies (e.g., international NGOs, donor agencies) continue to decrease funding. Especially in the early stages of the program, communities were assisted both financially and technically by international NGOs; however, it seems unlikely that this support will continue indefinitely, potentially causing problems with regard to conservancy governance on the community level (Boudreaux & Nelson, 2011) Furthermore, rising wildlife numbers are expected to go hand-in-hand with an increase in human-wildlife conflicts. The official NACSO report on community conservation in Namibia mentions an escalation in predator attacks on livestock (NACSO, 2018, p. 45). Without sufficient financial incentives for local communities, these increased costs of conservation may trigger fundamental opposition to CBNRM among local communities.

E.A.B - Selected Conservancies

Our research was concentrated in and around two conservancies located in the Kavango East region in northeastern Namibia: Joseph Mbambangandu Conservancy (JMC) and the George Mukoya Conservancy (GMC). The selected conservancies are not atypical when compared to the remaining 84 Namibian programs. A considerable number of conservancies generate little to no income for local communities and lack the capacity to engage in conservation or tourism activities. Many others manage to generate some income but fail to provide substantial benefits for the local population beyond a few employment opportunities. Based on the available data, the GMC and especially the JMC can be identified as belonging to these lower-achieving categories of conservancies; consequently, they should be regarded as representative of a significant portion of conservancies in Namibia and potentially also of other community-based schemes for forests or fisheries in Sub-Saharan Africa and elsewhere.

The Joseph Mbambangandu Conservancy (JMC) is located approx. 30 km to the east of the regional capital Rundu, directly between the banks of the Okavango River and the main road. It was established in 2004 (the 31st conservancy in Namibia), making it the oldest conservancy in the Kavango regions. Its four villages and the surrounding dwellings are home to about 1,700 people. At only 43 km2, it is one of the smallest conservancies in Namibia. Although the conservancy is home to hippos, crocodiles and various exotic bird species, it is reported to profit neither from hunting nor from eco-tourism. For 2014 and 2016, NASCO reports no income generation by the conservancy (NACSO, 2014, 2016b). The second conservancy included in our study – the George Mukoya Conservancy (GMC), established in 2005 (the 41st conservancy in Namibia) – is located further east, toward the Zambezi region, and borders the Khaudum Game Park on the north. With a total area of 486 km2, it is significantly larger than the JMC, albeit less densely populated (990 inhabitants). Thanks to its more remote location compared to the JMC, this conservancy features two of the "Big Five" safari animals (elephants and leopards). Moderate income figures (mainly from hunting, but still less than half of the average Namibian conservancy income) as well as records of wildlife monitoring and anti-poaching measures suggest that the GMC can be considered somewhat more successful than the JMC, both with regard to financial condition and conservation efforts (NACSO, 2016a).

Despite these differences between the two selected conservancies, we do not find indications that respondents in the JMC perceive conservancies more critically than respondents in the GMC. In both conservancies, the vast majority of respondents agree that conservancies are beneficial for both the participating communities (83%) and the wildlife population (96%). At the same time, we do not find support for the assumption that respondents outside conservancies perceive CBNRM more critically.

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E.B – Valuation Scenario and Questionnaire

Introductory Information (including data confidentiality statement)

Hello, my name is Marco Nilgen. I am a student from Germany, currently working as a student assistant, while pursuing a degree in economics at the University of Marburg in Germany. My team and me are carrying out a survey in the Kavango-East region. We want to improve our understanding about your livelihoods and your use and valuation of natural resources. I would like to assure you that all the data and information collected in this study will be used exclusively for scientific research and will be treated confidentially and anonymously. I am not supported by any kind of development or conservation project and the data collected in this study will not be given to anyone who can support local communities in this area. All I am interested in is learning from your responses to the survey questions. Be sure that your participation is highly appreciated and will help me in my course of study. Please feel free to ask me any kind of question and thanks a lot in advance!

IMPORTANT: It is important that you answer all questions honestly and according to your best knowledge. Most questions will ask you about your opinion about different topics related to nature and its conservation. There are no wrong answers. Remember, your responses will be treated confidentially and anonymously.

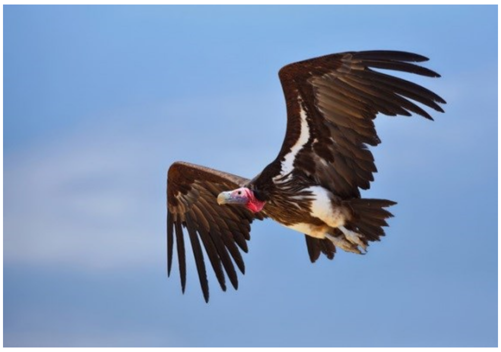
PAYMENT: At the end of the interview, you will receive a payment of 30 N$ for your participation. This money is yours and you can do with it whatever you want. Please be aware that your responses during this survey will not affect your payment in any way.

IMPORTANT: At any point of this interview, if you feel unsure about your understanding of a question or a statement, please feel free to ask the interviewer to repeat it or explain again. Please take all the time you need to think about your responses and evaluate your options.

Namibian Vultures

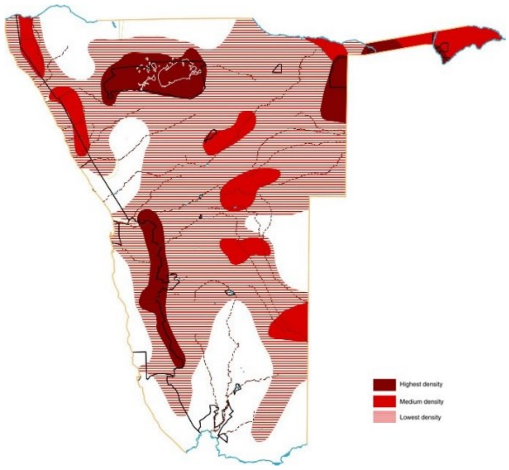
(NOTE: This section was read out by one of the interviewers in RuKwangali to a group of six respondents. Every picture was shown to the respondent on the tablet screen)

Namibia is home to seven different vulture species. One of them is the Lappet-faced vulture (Torgos Tracheliotos). Here you can see a few pictures of the Lappet-faced vulture.



The Lappet-faced vulture is one of the largest and strongest vulture species on the African continent. It can grow up to 1.2 meters and weigh up to 8 kg. Lappet-faced vultures are known to live up to 20 years.

The Lappet-faced vulture can be seen in nearly all regions of Namibia. This is because vultures range widely in search for food. Here you can see a map that depicts the distribution of the Lappet-faced vulture in Namibia. The darker the shade of red, the more frequently a Lappet-faced vulture is seen in this region. As you can see, the Lappet-faced vulture also occurs in the Kavango-East region.



Lappet-faced vultures are scavenging birds that mainly feed from animal carcasses. These may include elephants and other mammals, but also smaller birds or reptiles killed by predators or road kills. Here you can see a picture of vultures feeding on an animal carcass.

These vultures build single nests with only one egg. One pair of Lappet-faced vultures produce only about one young in two years. Here you can see a picture of a vulture nest.

(NOTE: The respondents were given time to discuss their responses to the following questions and then gave one group response)

Now, I will read out a few statements about vultures in general. I would like you to discuss every statement in your group and then state your group's level of agreement according to the scale you can see on the screen. On this scale +2 means "I strongly agree", +1 means "I agree to some extent", 0 means "I neither agree nor disagree", -1 means "I disagree to some extent" and -2 means "I strongly disagree".

1. Vultures are foul and disgusting animals.
2. Vultures are declining in our area.
3. Vultures are beneficial to humans.
4. Other people kill vultures.

Now, I will ask you a few questions regarding your experience with vultures. Please answer and discuss as a group! Answer with "yes", "not sure" or "no"!

1. Have you ever heard about the Lappet-faced vulture?
2. Have you ever seen a Lappet-faced vulture?
3. Have you ever seen any other kind of vulture in this region?

The Importance of Vultures

Vultures provide a number of important services that are beneficial to humans. Wild animals may die for different reasons: examples are predator kills, malnutrition, old age, disease or poisoning. Without vultures eating animal carcasses, dead animals can spread dangerous diseases in animals and people. One example for these diseases is rabies, which is also a problem in the Kavango-East region among animals but also among people. Vultures are valuable: A study estimated the value of a single vulture's waste disposal per year to be around 120.000 NAD.

The Current Status of Namibian Vultures

Six of the seven vulture species that occur in Namibia are categorized as endangered, or even critically endangered by the International Union for Conservation of Nature (IUCN). So is the Lappet-faced vulture. The bird is estimated to have experienced an 80% population decline over the last three generations. Data suggests that there are only about 1000 Lappet-faced vultures left throughout Namibia. If this trend continues, the Lappet-faced vulture could disappear from Namibia completely. This rapid population decline is mainly caused by the following reasons:

1. Accidental poisoning from farmers who want to protect their livestock from predators and use poison. Lappet-faced vultures feed on the poisoned carcasses and die too.
2. Deliberate poisoning by farmers who falsely believe Lappet-faced vultures to be predators and a threat to their livestock. However, this is not true!

3. Electrocution through vulture-unfriendly power lines.

4. Nest disturbance by humans to which the Lappet-faced vulture is highly sensitive.

Thanks a lot for your attention! Now the individual interviews will begin. You will be assigned to one of the interviewers.

Reasons you might Value Rare and Endangered Species

You will remember our introduction about the Lappet-faced vulture and its status as an endangered species. Is there anything you would like us to repeat or explain about the Lappet-faced vulture? (Wait for response - If yes, show pictures again and explain). Now, I will read statements about your personal perception of rare and endangered species. I would like you to choose your three most important reasons from the list.

I might value the protection and conservation of rare and endangered species because... (choose your favorite three reasons from the list)

1. I enjoy seeing different kinds of wildlife.
2. Animals attract tourists who bring money to this region.
3. Every species has a purpose in an ecosystem and their extinction can have bad consequences.
4. I would like the diversity of animals and plants to be preserved for future generations.
5. It makes me happy to know that endangered species continue to exist.
6. The large variety of species in this country is part of our cultural heritage.

Project to save the Namibian Lappet-faced Vulture

Now suppose, the Namibian Nature Foundation (NNF) supports a project that could help to stop the nationwide population decline of the Lappet-faced vulture. This non-profit project is trying to save and strengthen the Namibian population of the Lappet-faced vulture in the following ways:

1. Improve knowledge on the occurrence, distribution and population dynamics of the Lappet-faced vulture by ringing programs (the feet of the birds are equipped with a ring to identify them in the future).
2. Reduction of Lappet-faced vulture poisoning by farmers through awareness campaigns and workshops in farming communities.
3. Creation of "Vulture Restaurants". Vulture Restaurants are secure places where carcasses and food-leftovers are regularly placed. Vultures return to these places and can enjoy a poison-free meal.

This program actively contributes to saving the remaining population of Lappet-faced vultures in Namibia from extinction. Supporting this program could help in increasing the population levels of the Lappet-faced vultures for the coming generations.

The Valuation Questions

I would like to ask you what the maximum amount of NAD you would be willing to give to this NNF project right now as a one-time donation. IMPORTANT: Before you answer, please think about your response carefully. Keep in mind your personal income situation and alternative possibilities to spend your money. Similar studies showed that people tend to overstate their willingness to pay in hypothetical scenarios, because they do not consider properly how much their spending would affect their personal budget. It is important that you answer as honestly and realistically as possible.

Individual version: What would be the maximum amount you would be willing to pay in NAD to support the NNF project to protect and restore the Namibian population of Lappet-faced vultures? Please choose one amount from the list below.

Thanks for your honest response!

Group version: What would be the maximum amount per person you would be willing to pay in NAD to support the NNF project to protect and restore the Namibian population of Lappet-faced Vultures? Please discuss in your group for 2-3 minutes and then choose one amount from the list below.

Thanks for your honest response!

(NOTE: In case the respondents had a group discussion about their willingness to pay, the participants were taken to their individual interviews at this point.)

You just discussed how much you would be willing to donate to the project in your group. Now, what would be your individual maximum amount you would be willing to pay in NAD to support the NNF project to protect and restore the Namibian population of lappet-faced vultures? Again, please choose the amount from the list below.

Thanks for your honest response!

Motivation Behind the Willingness to Pay Response

In case of a positive willingness to pay: Now, I would like to ask you about your personal motivation behind your answer. Why would you like to donate to this project?

(NOTE: The respondents could answer freely. The interviewers then chose the response that was most according to what the respondent said.)

1. I think it is important to protect Namibia's population of Lappet-faced vultures.
2. I would like to lower the amount of accidental or deliberate vulture killings in the future.
3. I think that vultures need to be protected because they provide important services to the local people.
4. My donation expresses my true desire to help the project.
5. I think it is important to save endangered species.
6. I would like to contribute to a good cause.
7. I stated that I would like to donate, because I do not really have to pay.
8. Another reason.

In case of a zero willingness to pay: Now, I would like to ask you about your personal motivation behind your answer. What was the main reason for you to say that you would not donate to this project?

(NOTE: The respondents could answer freely. The interviewers then chose the response that was most according to what the respondent said.)

1. I cannot afford to donate to this cause.
2. The project is not worth anything to me.
3. I do not think that the decrease in Lappet-faced vulture populations is a problem.
4. I do not think that the Vultures Namibia project works.
5. The government should pay for this project.
6. I need more information on the subject matter to answer the question.
7. It is unfair to expect me to donate for this project.
8. Another reason.

Your Agreement with the Following Statements

Now, I will read out a few statements about different topics. I would like you to enter your personal level of agreement according to the scale you can see on the screen. On this scale +2 means "I strongly agree", +1 means "I agree to some extent", 0 means "I neither agree nor disagree", -1 means "I disagree to some extent" and -2 means "I strongly disagree".

1. The government should spend more money on nature conservation programs, even if this money would be lost on other ends.
2. If I would learn about a community member pursuing illegal hunting (poaching) activities, I would report this to the local authorities.

3. Humans were meant to rule over the rest of nature.
4. Local communities have a stronger responsibility to contribute to nature conservation than the national government.
5. The balance of nature is delicate and easily upset.
6. I think that the communities living in the local conservancies profit from living in a conservancy.
7. I think that the Namibian government profits more from the establishment of conservancies than the local communities.
8. The establishment of conservancies in this region is beneficial for wildlife populations.
9. I think that the establishment of conservancies in the Kavango-East region leads to increased human-wildlife conflict.
10. I think that the profits (e.g from tourism) generated in local conservancies are distributed fair among community members.
11. I think that the establishment of conservancies in the Kavango-East region creates artificial boundaries between local communities, leading to exclusion and conflict.
12. I go out on legal hunting activities regularly.
13. This community is active in coordinating and controlling the burning of grass- and bushlands for agriculture.

Socioeconomic Questions

Now we are almost done. I would like you to answer a few questions about yourself.

How old are you? (in years)

What is the total number of members in your household?

How many children do you have?

How many years did you went to school?

What amount of money do you spend in a month on average? (approx. in NAD)

Have you ever contributed to an environmental organization by workforce or money?

Did you vote in the last Namibian general election?

What do you think is the motivation for our research? Select one of the reasons from the list below!

(NOTE: A list of four possible responses was shown to the respondents)

1. To see whether this community should receive monetary support.
2. To find out more about this community and the people living in it.
3. To distribute money.
4. To inform my research.

THANKS A LOT FOR YOUR PARTICIPATION! Now you will receive your 30 NAD from the interviewer. You will find the money in this envelope.

Before you leave, you will have the opportunity to donate some portion of this money to a project called "Vultures Namibia". Just like the project in the hypothetical scenario, "Vultures Namibia" is supported by the NNF and helps the Namibian Vulture populations in the same way. (Ask the respondent if he would like you to repeat the activities of the project). Please do as follows: Take your envelope with the money and go behind the car. Then, leave whatever amount you would like to donate to the "Vultures Namibia" project in the envelope and put it in the box. Me and my team will donate the money to the NNF for you. Of course, your donation would be anonymous. IMPORTANT: Even if you choose not to donate any money to the Vultures Namibia project, I would kindly ask you to put the empty envelope in the box. Again, thanks a lot for your participation.

E.C – Additional Tables

Table E.C1 - Probit Regression Models, Conservancy and Group Deliberation Effect, DV: Dummy for Positive WTP and Donation

	WTP (1)	(2)	Donation (3)	(4)
Conservancy	-0.196*	-0.217**	-0.182	-0.210*
	[-0.357,-0.035]	[-0.353,-0.081]	[-0.374,0.010]	[-0.400,-0.020]
Group Deliberation=1	-0.054	-0.065	-0.024	-0.017
	[-0.220,0.112]	[-0.220,0.090]	[-0.154,0.107]	[-0.142,0.108]
Female=1		-0.069		-0.047
		[-0.216,0.079]		[-0.224,0.129]
Age (years)		-0.036***		-0.035**
		[-0.056,-0.016]		[-0.055,-0.014]
Age squared (years)		0.000**		0.000***
		[0.000,0.001]		[0.000,0.001]
Childs in HH (count)		0.001		0.006
		[-0.021,0.024]		[-0.025,0.037]
Adults in HH (count)		-0.001		0.005
		[-0.012,0.011]		[-0.012,0.023]
Education (years)		-0.023*		-0.016
		[-0.045,-0.001]		[-0.043,0.010]
Monthly expenses (NAD)		-0.000		0.000
		[-0.000,0.000]		[-0.000,0.000]
Obs.	156	156	156	156
Chi2	5.085	45.803	3.512	18.080
p-Val	0.079	0.000	0.173	0.034
Pseudo R2	0.068	0.200	0.029	0.073

Note: Robust standard errors clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1, 95% confidence intervals in brackets

Table E.C2 - Tobit Regression Models, Conservancy and Group Deliberation Effect

	WTP		Donation	
	(1)	(2)	(3)	(4)
Conservancy	-0.949	-1.276	-1.005	-0.890
	[-2.989,1.091]	[-2.980,0.428]	[-2.171,0.160]	[-2.115,0.336]
Group Deliberation=1	-1.715	-1.844	-0.942	-0.945
	[-3.901,0.470]	[-4.140,0.453]	[-2.197,0.313]	[-2.063,0.172]
Female=1		-0.366		0.670
		[-2.233,1.501]		[-0.556,1.896]
Age (years)		-0.525**		-0.188**
		[-0.874,-0.176]		[-0.302,-0.073]
Age squared (years)		0.005**		0.002**
		[0.001,0.009]		[0.001,0.003]
Childs in HH (count)		0.027		0.295
		[-0.248,0.301]		[-0.040,0.629]
Adults in HH (count)		-0.012		-0.067
		[-0.204,0.180]		[-0.190,0.057]
Education (years)		-0.057		-0.066
		[-0.392,0.278]		[-0.251,0.118]
Monthly expenses (NAD)		-0.001		0.000
		[-0.001,0.000]		[-0.001,0.001]
Obs.	156	156	156	156
Left-censored	31	31	54	54
Right-censored	5	5	0	0
F-Stat	1.680	1.548	2.473	3.174
p-Val	0.190	0.136	0.088	0.002
Pseudo R2	0.004	0.017	0.008	0.028

Note: Robust standard errors clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1, 95% confidence intervals in brackets, WTP: upper limit: 40, lower limit: 0, Donation: upper limit: 30, lower limit: 0

Table E.C3 - Tobit Regressions, DV: Hypothetical Bias

	Positive/negative		Absolute	
	(1)	(2)	(3)	(4)
Conservancy	0.171	-0.063	-0.217	-0.212
	[-1.625,1.967]	[-1.690,1.564]	[-2.014,1.579]	[-1.943,1.519]
Group Deliberation=1	-0.026	-0.306	-0.473	-1.025
	[-2.063,2.011]	[-2.422,1.809]	[-2.602,1.655]	[-3.224,1.173]
Female=1		-0.333		1.297
		[-2.601,1.936]		[-1.062,3.656]
Age (years)		-0.283		-0.375
		[-0.719,0.152]		[-0.783,0.033]
Age squared (years)		0.002		0.003
		[-0.002,0.007]		[-0.001,0.007]
Childs in HH (count)		-0.036		0.293
		[-0.299,0.227]		[-0.026,0.612]
Adults in HH (count)		-0.016		-0.067
		[-0.282,0.249]		[-0.330,0.195]
Education (years)		-0.072		-0.118
		[-0.442,0.298]		[-0.418,0.182]
Monthly expenses (NAD)		-0.001		-0.002*
		[-0.002,0.000]		[-0.003,-0.000]
Obs.	156	156	156	156
Left-censored	111	111	98	98
Right-censored	5	5	5	5
F-Stat	0.018	2.059	0.128	1.464
p-Val	0.983	0.037	0.880	0.167
Pseudo R2	0.000	0.017	0.000	0.024

Note: Robust standard errors clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1, 95% confidence intervals in brackets, Positive/negative: upper limit: 40, lower limit: -30, Absolute: upper limit: 40, lower limit: 0

Table E.C4 - Tobit Models Testing for Interaction Effects Between Group Deliberation and Conservancy Status

	WTP		Donation	
	(1)	(2)	(3)	(4)
Group Deliberation=1	0.349	-0.289	-0.432	-0.700
	[-1.975,2.673]	[-3.147,2.569]	[-1.991,1.127]	[-2.090,0.691]
Conservancy	1.330	0.495	-0.441	-0.609
	[-1.511,4.172]	[-2.291,3.281]	[-2.193,1.310]	[-2.386,1.168]
Conservancy x Group Delib.=1	-4.071*	-3.203	-1.092	-0.545
	[-7.358,-0.783]	[-7.072,0.665]	[-3.313,1.128]	[-2.815,1.725]
Female=1		-0.270		0.688
		[-2.210,1.669]		[-0.553,1.928]
Age (years)		-0.464**		-0.178**
		[-0.806,-0.123]		[-0.289,-0.067]
Age squared (years)		0.004*		0.002**
		[0.001,0.008]		[0.001,0.003]
Childs in HH (count)		-0.001		0.290
		[-0.277,0.276]		[-0.039,0.618]
Adults in HH (count)		0.003		-0.065
		[-0.177,0.183]		[-0.186,0.057]
Education (years)		-0.067		-0.068
		[-0.406,0.273]		[-0.256,0.119]
Monthly expenses (NAD)		-0.001		0.000
		[-0.001,0.000]		[-0.001,0.001]
Obs.	156	156	156	156
Left-censored	31	31	54	54
Right-censored	5	5	0	0
F-Stat	1.914	1.389	1.746	4.205
p-Val	0.130	0.191	0.160	0.000
Pseudo R2	0.010	0.021	0.010	0.029

Note: Robust standard errors clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1, 95% confidence intervals in brackets, WTP: upper limit: 40, lower limit: 0, Donation: upper limit: 30, lower limit: 0

Table E.C5 - Sample Characteristics by Conservancy Status

Variable	*N*	*(1)* *No Conservancy* *Mean/SD*	*N*	*(2)* *Conservancy* *Mean/SD*	*N*	*(3)* *Total* *Mean/SD*	*t-test* *Difference* *(1)-(2)*
Female	84	0.500	72	0.319	156	0.417	0.181**
		[0.503]		[0.470]		[0.495]	
Age (years)	84	42.952	72	44.944	156	43.872	-1.992
		[15.672]		[17.582]		[16.556]	
Age squared (years)	84	2087.595	72	2324.833	156	2197.090	-237.238
		[1478.435]		[1681.287]		[1574.594]	
Childs in HH (count)	84	4.464	72	4.806	156	4.622	-0.341
		[3.016]		[3.334]		[3.161]	
Adults in HH (count)	84	8.476	72	9.750	156	9.064	-1.274*
		[4.554]		[4.820]		[4.706]	
Education (years)	84	5.762	72	5.625	156	5.699	0.137
		[3.842]		[3.717]		[3.773]	
Monthly expenses (NAD)	84	853.095	72	706.250	156	785.321	146.845
		[908.433]		[661.734]		[804.913]	
F-test of joint significance (F-stat)							1.929*
F-test, number of observations							156

Note: The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table E.C6 - Sample Characteristics by Deliberation Method

Variable	*N*	*(1)* *Individual Deliberation* *Mean/SD*	*N*	*(2)* *Group Deliberation* *Mean/SD*	*N*	*(3)* *Total* *Mean/SD*	*t-test* *Difference* *(1)-(2)*
Female	78	0.385	78	0.449	156	0.417	-0.064
		[0.490]		[0.501]		[0.495]	
Age (years)	78	44.500	78	43.244	156	43.872	1.256
		[16.922]		[16.267]		[16.556]	
Age squared (years)	78	2262.936	78	2131.244	156	2197.090	131.692
		[1655.666]		[1496.956]		[1574.594]	
Childs in HH (count)	78	4.679	78	4.564	156	4.622	0.115
		[3.285]		[3.052]		[3.161]	
Adults in HH (count)	78	9.090	78	9.038	156	9.064	0.051
		[4.644]		[4.798]		[4.706]	
Education (years)	78	5.910	78	5.487	156	5.699	0.423
		[3.746]		[3.813]		[3.773]	
Monthly expenses (NAD)	78	923.846	78	646.795	156	785.321	277.051**
		[937.614]		[621.438]		[804.913]	
F-test of joint significance (F-stat)							0.946
F-test, number of observations							156

Note: The value displayed for t-tests are the differences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.