Essays on Motivated Reasoning in the Face of Climate Change

Inaugural - Dissertation

zur

Erlangung der wirtschaftswissenschaftlichen Doktorwürde

des Fachbereichs Wirtschaftswissenschaften

der Philipps-Universität Marburg

eingereicht von:

Matthias Mayer, M.Sc.

aus Innsbruck

Erstgutachter:	Prof. Dr. Björn Vollan
Zweitgutacher:	Prof. Dr. Wolfgang Kerber
Einreichungstermin:	08.09.2022
Prüfungstermin:	13.12.2022
Erscheinungsort:	Marburg
Hochschulkennziffer:	1180

Eidesstattliche Erklärung

Vor- und Zuname:	Matthias Mayer
Geburtsdatum:	22.11.1989
Geburtsort:	Innsbruck

Hiermit versichere ich an Eides statt, dass ich die vorgelegte Dissertation selbst und ohne fremde Hilfe verfasst, eventuelle Beiträge von Ko-Autoren dokumentiert, nicht andere als die in ihr angegebenen Quellen oder Hilfsmittel benutzt, alle vollständig oder sinngemäß übernommenen Zitate als solche gekennzeichnet sowie die Dissertation in der vorliegenden oder einer ähnlichen Form noch bei keiner anderen in- oder ausländischen Hochschule anlässlich eines Promotionsgesuchs oder zu anderen Prüfungszwecken eingereicht habe.

Marburg, den 05.09.2022

Dokumentation der Ko-Autorenschaft

Kapitel 1 wurde gemeinsam mit Maximilian N. Burger und Björn Vollan konzipiert. Der Überblick über die verhaltensökonomische Theorie und das integrierte Modell für nachhaltige Transformation wurden von mir verfasst. Maximilian N. Burger hat die Erkenntnisse aus anderen Verhaltenswissenschaften zusammengefasst. Die Einleitung und die Schlussfolgerung wurden gemeinsam verfasst.

Kapitel 2 habe ich in Alleinautorenschaft verfasst.

Kapitel 3 wurde gemeinsam mit Ivo Steimanis und Björn Vollan konzipiert und verfasst. Die Datenerhebung, -aufbereitung und -analyse wurden von Ivo Steimanis und mir durchgeführt. Björn Vollan hat die Mittel zur Finanzierung der Studie erworben.

Kapitel 4 wurde gemeinsam mit Maximilian N. Burger und Ivo Steimanis verfasst. Die Idee und das Konzept stammen von Maximilian N. Burger und mir. Die Mittel zur Finanzierung wurden gemeinsam erworben. Die Datenerhebung und -aufbereitung wurden von Maximilian N. Burger und mir durchgeführt. Die Datenanalyse, die Verfassung, und die Überarbeitungen wurden von allen Autoren gemeinsam durchgeführt.

Kapitel 5 wurde gemeinsam mit Maximilian N. Burger und Björn Vollan konzipiert. Die Idee des Projektes stammen von Björn Vollan, der auch die Finanzierung organisierte. Die Datenerhebung, -aufbereitung und -analyse wurden von Maximilian N. Burger und mir durchgeführt. Die erste Version stammt von Maximilian N. Burger. Die neueste Fassung stammt von mir.

Zusammenfassung

Motiviertes Denken — die Tendenz nach Informationen zu suchen und sie so zu interpretieren, dass sie bereits vorhandene Überzeugungen, Werte und Identitäten bestätigen — ist zentral, um die Entstehung polarisierender Überzeugungen zu erklären. Zu verstehen, warum Menschen sich auf diese Art des Denkens einlassen, und Wege zu finden, diese Denkweise zu umgehen, ist für jede informationsbasierte Gesellschaft von entscheidender Bedeutung, insbesondere angesichts des Klimawandels und globaler Pandemien.

Die hier vorliegende kumulative Dissertation besteht aus fünf Aufsätzen, die das motivierte Denken aus verschiedenen Blickwinkeln beleuchten. Der erste Aufsatz legt das theoretische Fundament für die folgenden Aufsätze. Er verbindet die neuesten Forschungsergebnisse der Verhaltensökonomie in einem konzeptionellen Rahmen, der die Rolle von Mechanismen beleuchtet, die der Entwicklung von Überzeugungen und Entscheidungen zugrunde liegen. Hierzu gehören kognitive Kategorien, Identitäten, Narrative, Werte und Weltanschauungen, die unter dem Sammelbegriff mentales Modell zusammengefasst werden können. Dieser konzeptionelle Rahmen hilft, die wesentlichen Faktoren des motivierten Denkens zu verstehen, das u. a. ausgelöst werden kann, um die eigene Identität oder die eigenen Werte zu schützen oder um bestimmte Narrative oder Weltanschauungen aufrechtzuerhalten. Die Verwendung mentaler Abkürzungen, so genannter Heuristiken, kann das motivierte Denken ebenfalls bestärken. Die Aufsätze zwei und fünf befassen sich mit der empirischen Messung des motivierten Denkens und untersuchen Faktoren, die dieses erklären können. Der dritte und vierte Aufsatz befasst sich dagegen mit den Folgen motivierten Denkens. Während der dritte Aufsatz untersucht, warum Menschen in Gebieten verbleiben, die vom Anstieg des Meeresspiegels bedroht sind, befasst sich der vierte Aufsatz mit der Frage, wie polarisierende Überzeugungen über COVID-19-Impfstoffe überwunden werden können, die dazu führen können, dass Menschen ihre Impfung verzögern oder sogar ablehnen.

Im ersten Aufsatz, der von Maximilian N. Burger, Björn Vollan und mir verfasst wurde, diskutieren wir die Notwendigkeit eines systematischen Wandels unserer Gesellschaft, um zu einer Zivilisation zu gelangen, die innerhalb der ökologischen Grenzen gedeihen kann, ohne dabei die Lebensgrundlagen künftiger Generationen zu zerstören. Wir umreißen das Potenzial der Verhaltensökonomie zu dieser Transformation beizutragen. Wir argumentieren, dass die Verhaltensökonomie bisher hauptsächlich zum Verständnis und zur Verwirklichung marginaler Verhaltensveränderungen beigetragen hat, nicht aber zu tiefgreifenden, nachhaltigen Veränderungen. Regeln, wie zum Beispiel Gesetzte und Vorschriften, und Anreize, wie zum Beispiel preisbasierte Mechanismen, können zwar zur

Steuerung bestimmter Verhaltensweisen wirksam sein, ändern aber nicht die zugrunde liegenden Werte und Einstellungen. Diese Maßnahmen fördern daher nur selten eine Veränderung des allgemeinen Verhaltens. Wir erarbeiten einen konzeptionellen Rahmen, der auf aktuellen Forschungsergebnissen der Verhaltensökonomie aufbaut und diese mit Erkenntnissen aus anderen Verhaltenswissenschaften kombiniert, um weitreichende Veränderungen im menschlichen Verhalten zu untersuchen.

Im zweiten Beitrag untersuche ich motiviertes Denken im Kontext der Risiken des globalen Meeresspiegelanstiegs. Für diese Studie führte ich eine Online-Umfrage (N = 885) in den Vereinigten Staaten durch. Ich befrage sowohl Personen die in weniger exponierten, landumschlossenen Landkreisen leben, als auch Personen, die in Landkreisen leben, die Überschwemmungen, Küstenerosion und Stürmen ausgesetzt sind. Diese Gefahren werden durch den Anstieg des Meeresspiegels weiter verstärkt. Auf den Salomoneninseln (N = 478), in Bangladesch (N = 229) und Vietnam (N = 366) leitete ich Forschungsteams von 6 bis 10 Assistenten, die Umfragen in Gebieten durchführten, die durch den Meeresspiegelanstieg stark gefährdet sind. Ich habe ein flexibles, umfragebasiertes Design zur Messung des motivierten Denkens entwickelt, das einen Vergleich zwischen verschiedenen Themen und Kontexten ermöglicht. Die Befragten wurden mit zwei gleichermaßen wahren, aber widersprüchliche, Informationen konfrontiert und gefragt welche der beiden Informationen (wenn überhaupt eine) von Menschen wie ihnen ignoriert werden sollte. Auch wenn die Informationen jeweils an die lokalen Gegebenheiten der vier Studienorte angepasst wurden, folgten sie dennoch stets demselben Muster: Eine Information betonte die Risiken des Meeresspiegelanstiegs für das lokale Gebiet, die andere die Anpassungsmöglichkeiten oder alternative Erklärungen für die erhöhten Risiken von Überschwemmungen und Küstenerosion.

Die Ergebnisse zeigen, dass es zwischen den Ländern große Unterschiede im motivierten Denken sowie der Begründung für dieses gibt. Die Ergebnisse aus den Vereinigten Staaten zeigen die erwartete Polarisierung entlang der Parteigrenzen, wobei die Republikaner eher angeben, dass die Risiken des Meeresspiegelanstiegs ignoriert werden sollten, während die Demokraten eher angeben, dass die Adaptionsmöglichkeiten ignoriert werden sollten. Im Gegensatz dazu geben die Befragten auf den Salomoninseln fast ausschließlich an, dass die Adaptionsmöglichkeiten ignoriert werden sollten. In Vietnam wurden fast keine Anzeichen für motiviertes Denken gemessen, und in Bangladesch finde ich zwar ein ähnliches Muster motivierten Denkens wie in den Vereinigten Staaten, aber mit einer viel schwächeren Polarisierung. Insgesamt deuten diese Unterschiede zwischen den Ländern darauf hin, dass die Gründe, warum Menschen angesichts der Risiken des Meeresspiegelanstiegs motiviertes Denken betreiben, vielschichtig und komplex sind und vor allem vom lokalen soziopolitischen Kontext abhängen. In diesem Beitrag vertrete ich

daher die Auffassung, dass motiviertes Denken politisch bedingt ist und nicht das Ergebnis kognitiver Eigenschaften oder von Persönlichkeitstypen.

Der dritte Aufsatz, der von Ivo Steimanis, Björn Vollan und mir verfasst wurde, basiert auf den Umfragedaten aus Bangladesch (N = 247) und Vietnam (N = 377). Wir untersuchen, warum die Menschen in den vom Meeresspiegelanstieg bedrohten Küstenregionen, wie dem Ganges- und Mekong-Delta, ausharren. Um die gesellschaftliche Widerstandsfähigkeit in risikoreichen Umgebungen besser zu verstehen, analysierten wir die Bindung der Menschen an ihren Wohnort, ihre Risikobereitschaft und wie sich diese in Reaktion auf extreme Wetterereignisse verändert. Unsere Ergebnisse bestätigen, dass die meisten Menschen es vorziehen an ihrem Wohnort zu bleiben. Entscheidend ist jedoch, dass selbstberichtete Erfahrungen von klimabedingten Gefahren mit einer höheren Risikoaversion und einer stärkeren Bindung an den Wohnort einhergehen. Dies wiederum verstärkt die Präferenzen der Menschen, in gefährlichen Umgebungen zu verweilen. Zudem streben Menschen, die angeben klimabedingten Gefahren erlebt zu haben, eher danach, in einkommensstarke Länder zu migrieren als andere. Eine derartige Auswanderung liegt aber wahrscheinlich jenseits ihrer Möglichkeiten. Von zentraler Bedeutung ist, dass die Veränderungen in den Bestrebungen ins Ausland zu ziehen, mit den Veränderungen in der Risikoaversion und der Ortsbindung zusammenhängen. Die Erkenntnis, dass diese Präferenzen mit extremen Wetterereignissen zusammenhängen und dass diese wiederum mit dem Bestreben in einkommensstarke Länder zu ziehen interagieren, kann zu einem besseren Verständnis beitragen, warum so viele Menschen in gefährlichen Gegenden bleiben. So könnten sich beispielsweise die Präferenzen der Menschen dahingehend entwickeln, dass sie sich länger in gefährlichen Regionen aufhalten, in denen sie zunehmend den unmittelbaren und graduellen Auswirkungen von klimabedingten Gefahren ausgesetzt sind. Dies wiederum würde das Risiko für sozioökonomisch marginalisierte Haushalte erhöhen, weiter in die Armut zu geraten. Letztendlich könnten sie die Möglichkeit verlieren, in eine sicherere Gegend zu ziehen. Wir argumentieren, dass es dringend notwendig wäre, proaktive Maßnahmen zu entwickeln, um betroffene Gemeinschaften zu identifizieren, die Gefahr laufen, aufgrund von klimabedingten Gefahren (weiter) in die Armut abzurutschen.

Der vierte Aufsatz, verfasst von Maximilian N. Burger, Ivo Steimanis und mir, untersucht, ob die Impfmüdigkeit durch (i) die Entlarvung von Impfmythen oder (ii) die Hervorhebung der Vorteile einer Impfung verringert werden kann. Wir führten im Mai/Juni 2021 ein Umfrage-Experiment mit N = 1.324 ungeimpften Teilnehmern in Deutschland durch. Anschließend wurde eine Reihe von E-Mails verschickt, in denen die Informationen aus dem Umfrageexperiment vertieft wurden, und schließlich wurde drei Monate später, im September 2021, eine Nachbefragung durchgeführt, um festzustellen, ob die Teilnehmer sich impfen gelassen haben. Wir stellen fest, dass eine einmalige

Information, unabhängig von ihrem Inhalt, die Impfabsicht in dem Umfrageexperiment nicht erhöht. Die Vermittlung von Impfvorteilen über mehrere Wochen hinweg erhöhte jedoch die Wahrscheinlichkeit, sich impfen zu lassen, um 9 Prozentpunkte, was einem Anstieg von 27 Prozent im Vergleich zur Kontrollgruppe entspricht. Die Entlarvung von Impfmythen hatte keinen signifikanten Effekt. Unsere Ergebnisse legen nahe, dass staatliche Maßnahmen wie Informationskampagnen der Hervorhebung von Vorteilen Vorrang vor der Entlarvung von Impfmythen geben sollten. Zudem scheinen sich wiederholte Botschaften stärker auf das Impfverhalten auszuwirken als einmalige Botschaften, die möglicherweise selbst für eine Steigerung der Impfabsichten nicht ausreichen. Darüber hinaus deuten unsere explorativen Ergebnisse darauf hin, dass die Bereitstellung geringer monetärer Anreize zusätzlich zu einer Steigerung der Impfquoten beitragen könnte. Darüber hinaus unterstreicht unsere Studie, wie wichtig es ist, Interventionen außerhalb von Umfrageexperimenten zu testen, die sich auf die Messung von Impfabsichten — nicht von Handlungen — und auf unmittelbare Veränderungen von Einstellungen und Absichten — nicht auf langfristige Veränderungen — beschränkt sind.

Der fünfte und letzte Aufsatz dieser Dissertation, wurde von Maximilian N. Burger, Björn Vollan und mir verfasst, und untersucht die Polarisierung der deutschen Landwirte in Bezug auf die nachhaltige Transformation der Landwirtschaft. Wir haben N = 110 Online-Befragungen mit hessischen Landwirten durchgeführt, um herauszufinden, ob sie dazu neigen, motivationales Denken anzuwenden, wenn sie mit Informationen konfrontiert werden, die die Nachhaltigkeit ihrer landwirtschaftlichen Praktiken in Frage stellen. Obwohl wir sowohl bei konventionellen als auch bei ökologischen Landwirten Anzeichen für motiviertes Denken finden, scheinen ökologische Landwirte ideologisch viel stärker polarisiert zu sein als konventionelle Landwirte. Außerdem baten wir N = 821 Bürgerinnen und Bürger in einer Online-Umfrage, uns mitzuteilen, wie ihrer Meinung nach die Landwirte auf unsere Fragen geantwortet haben. Im Gegensatz zu den öffentlichen Erwartungen sind die Landwirte in unserer Umfrage weit weniger polarisiert, und insbesondere die konventionellen Landwirte sind viel aufgeschlossener und umweltbewusster, als es die Öffentlichkeit erwartet. Unsere Ergebnisse deuten darauf hin, dass die Landwirte in der Öffentlichkeit nicht richtig wahrgenommen werden und dass eine nachhaltige Transformation der Landwirtschaft in Deutschland nicht durch ein motiviertes Denken der Landwirte behindert wird. Darüber hinaus machen unsere Ergebnisse deutlich, dass eine binäre Unterscheidung zwischen ökologisch zertifizierter und konventioneller Landwirtschaft wichtige Unterschiede innerhalb der konventionellen Landwirtschaft außer Acht lässt. Viele der von uns befragten Landwirte wenden bereits weitgehend ökologische Verfahren an, sind aber nicht als solche zertifiziert. Eine genauere Klassifizierung, die nicht nur zwischen ökologisch zertifizierten und nicht zertifizierten

Landwirten unterscheidet, könnte den politischen Entscheidungsträgern dabei helfen, ihre Verordnungen gezielter zur Förderung einer nachhaltigen Landwirtschaft auszurichten.

Contents

1 A behavioral (economics) framework for sustainable transformation*

Matthias Mayer, Maximilian N. Burger, Björn Vollan[1†]

Abstract

Human activity has led to a steady degradation of the environment over the past decades, pushing the ecosystem to the brink of collapse. It is now clear that a dramatic change in behavior is needed to avoid system collapse. Economics has been striving to devise approaches to bring about this change. While the application of rational choice models saw the solution primarily in incentivization, the effectiveness of this was cast into doubt by findings from early behavioral economics. The realization that heuristics affect human thinking and acting led to the extension of the economic policy repertoire by including nudges. While hard rules, incentives, and nudges can change human behavior in specific situations, recent findings suggest that they are not sufficient to bring about the necessary change. Current behavioral economics research sheds light on the role of the mechanisms underlying human behavior. Factors scrutinized are categories, identities, narratives, worldviews, and values, which can be united under the collective term mental models. Through these mental models it is possible to explain not only linear decision processes as is conventional, but also dynamic ones. These dynamic processes consider factors that have been highlighted as important in other behavioral sciences, such as habits and positive spillovers. In this chapter, we present a conceptual framework that describes the analysis of human behavior including mental models. The framework combines insights from behavioral economics with those from other behavioral sciences to explore far-reaching changes in human behavior and thus provide a scientific basis for the necessary transformation.

Keywords: Sustainable transformation; Conceptual framework; Mental models; Habitual behaviors

* This essay has been accepted for publication as: Mayer, M., Burger, M. N., Vollan, B., (forthcoming). A Behavioural (Economics) Framework for Sustainable Transformation. In Bucciol, Tavoni, and Veronesi (Eds.), Behavioral Economics and the Environment: A Research Companion (chapter 2). Routledge. ISBN: 9781032003535

[1] Authors affiliation: School of Economics and Business, Universität Marburg, Germany

† Correspondence: Björn Vollan, bjoern.vollan@wiwi.uni-marburg.de

"We can't solve problems by using the same kind of thinking we used when we created them"
(attributed to Einstein)

1.1 Introduction

Human activities are increasingly found to have adverse effects on the Earth's geology and ecosystem (IPCC, 2021). In the current age of the Anthropocene, humanity has become a major force pushing the ecosystem to the brink of collapse (Rockström et al., 2009). The realization that we placed our habitat at risk generated substantial efforts in civil society and research to change human behaviors to prevent this outcome. However, there is a consensus that these efforts nevertheless fall far short of the changes needed (Matson et al., 2016; United Nations, 2019). This makes it ever more important for our societies to not just implement marginal changes but to transform into a more sustainable civilization that can thrive within the environmental boundaries without depleting the basis of our lives and that of future generations (Capstick et al., 2014).

We believe that behavioral economics — the pairing of individual-centered research (behavioral) with the science of the allocation of scarce resources (economics) — has great potential to contribute to this endeavor and supporting this sustainable transformation with practical policy recommendations. However, to fully emerge into this role, behavioral economics has to widen its perspective by incorporating dynamic aspects of human behavior. We contribute to this by presenting a snapshot of the current state of behavioral economics, enhancing it with models of other behavioral sciences applied to issues of sustainability, and deriving an integrated conceptual framework combining the two.

Building on the work of Kahneman (2011) and Hoff and Stiglitz (2016) we introduce an updated theoretical framework for behavioral sustainability economics. In this chapter, we argue that behavioral economics has, up to this point, mainly contributed to the understanding and realization of marginal changes, not deep sustainable transformations. Hard rules (i.e., command-and-control policies) and incentives (i.e., price-based mechanisms) may be effective in regulating specific actions but fail to alter underlying values and, hence, rarely promote a change in general behavior. A third policy tool that has gained much attraction in the last 15 years are nudges. These low-cost interventions have been shown to successfully guide behavior in certain situations (Hummel and Maedche, 2019). However, nudges seem to work only for specific actions, and only if supporting intrinsic or social values are already in place (Capstick et al., 2014). Furthermore, nudges do not seem to have a long-lasting effect but dissipate once removed (Nisa et al., 2019). Moreover, much attention in behavioral economics has been devoted to analyzing underlying mechanisms of independent actions and habitual behaviors. Yet, from a systems perspective, interventions for sustainable transformation of society have to

employ people's internal values and motivations to affect a whole category of behaviors, and not one singular context-specific decision. In other behavioral sciences, the formation of habits (Kurz et al., 2015) and positive spillover effects from one to other environmentally friendly behaviors (Corner and Clarke, 2017) appear to be central to explaining how sustainable behaviors form. However, these have barely been addressed in behavioral economic models and their explanatory power has been greatly overlooked (Matysková et al., 2020).

We scrutinize this point by paying closer attention to the underlying mechanisms, that is, how past experiences and behaviors can alter the underlying driving forces of future behavior. These underlying forces, which have been labeled mental models (Hoff and Stiglitz, 2016), include identities, categories, values, narratives, and worldviews. Mental models help us to distinguish between important and unimportant cues in a constant flow of sensory inputs (e.g., what we see, hear, and feel). These mental models have been applied especially when analyzing the plurality of stakeholders' perceptions, values, and goals (Lynam and Brown, 2012). They are simplified representations of how the world works that help us interpret inputs quickly without having to recall everything we know about it. Mental models vary in their accuracy and are highly context-dependent. Over time, we develop multiple mental models for different situations. For example, the same stimuli (e.g., a visually less appealing tomato in the supermarket) can be perceived differently by people with different mental models. A person with a more sustainable mental model may be less deterred by appearance focusing more on preventing food waste. Another person with a less pronounced sustainable mental model may simply perceive the tomato as a bad deal. As such, mental models are crucial for our interpretation of the world and our reaction to it. They can enhance polarization or facilitate a shared understanding of the world. Therefore, we see mental models as key to bringing about the transformation needed to sustain the basis of human life — our environment — in the future. For this reason, we advocate for a research agenda that focuses on mental models to induce habitual changes and enhance positive spillovers to enable behavioral economics to contribute to the solution of the challenges posed by climate change, biodiversity loss, deforestation, or pollution.

While a shift in attention from single action to deeper changes has been proposed (see for example Capstick et al., 2014; Corner and Clarke, 2017; John et al., 2009), we are among the first to provide a conceptual framework for behavioral economics including mental models, habits, and positive spillovers (see c.f., Schill et al., 2019). We deem it worthy at this point to make explicit that by setting the transformation towards more sustainable behavior as an aim, we take a normative stance. While this is uncommon in the field of economics (which often identifies itself as a positive science), it is a key feature of the emerging and vibrant field of sustainability science (Kates et al., 2001). The justification,

necessity, and inevitability of normative positions within social sciences in connection to sustainability have been discussed extensively elsewhere (Capstick et al., 2014; Matson et al., 2016). Furthermore, while some may well take a critical view of the paternalistic nature of transforming human behavior, we believe that all laws, rules, and regulations of society restrict individual freedom but they are in place to protect and maintain social well-being. Sustainability science points out the threats posed by climate change such as the destruction of life-supporting environmental systems and increased inequalities across time (i.e., between current and future generations) and space (i.e., between more and less exposed residents). As our behaviors, directly and indirectly, contribute to multiple environmental damages, there is a need to transform rather than marginally changing them. Influencing human behavior is only one approach, yet likely one of the most cost-effective ways (or "deep leverages") to combat our degrading environment (Meadows, 2009).

While in our approach we focus on the individual, their actions are always embedded in a societal context. Societal factors constituting this social context — such as (formal and informal) institutions, politics, power relations, technological transitions, and market dynamics — are mentioned only implicitly in our framework in the form of frames. It is important to emphasize that we do not do this because we consider the social context to be negligible. On the contrary, we see the mutual influence between individuals and their social context as pivotal for the transformation towards a sustainable society. For a detailed description of the interrelation between individuals and their societal environment, we recommend the framework presented by Matson and colleagues (Matson et al., 2016). As has been laid out there and elsewhere (Meadows, 2009) the transformation of human behavior should, however, be seen as central for the achievement of leading society on a sustainable trajectory.

1.2 The static framework employed in (behavioral) economics

The field of economics has undergone major revisions, that is, neo-classical repairs, to expand the field's mathematical understanding of the human mind (Gigerenzer, 2008; Güth, 2008). In this section, we summarize the recommendations for a sustainable transformation derived from theoretical frameworks of standard economics, behavioral economics, and other behavioral sciences.

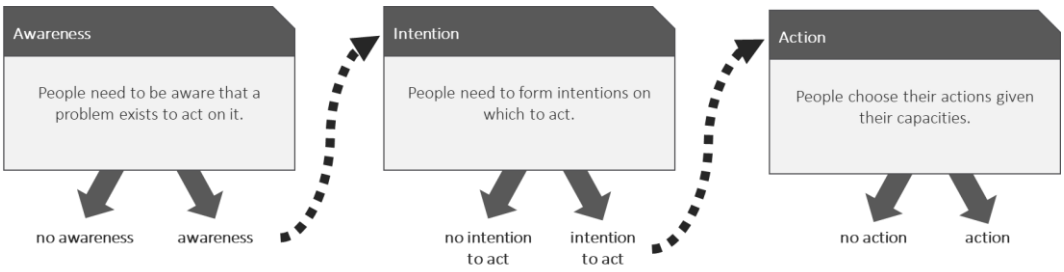
1.2.1 Standard economics

In economics, the rational choice model remains the default approach to explain behavior. While economists do not assume that people function like the stylized rational agents in their models, they nevertheless assume that people behave *as if* they were using similar

methods of reasoning (Friedman and Savage, 1948; Starmer, 2005). In the end, standard economics is more interested in people's choices than in the mental processes of how these choices came to be, and the assumption of fixed preferences allows standard economic analysis to treat mental processes as a black box. In this view, preferences are seen as the mental ordering of all potential choices from most preferred to least preferred with choices depending ultimately on peoples' constraints (e.g., financial, legal, or time).

In standard economics, decision-making is thus viewed as a linear process, where agents (1) build awareness and recognize that there is a need to act, (2) develop an intention to act based on this awareness, and finally (3) implement their intended actions given their capacities (see Fig. 1.1). Feedback effects exist in the sense that actions might change an individual's capacity (e.g., reduce the financial capital available), which in turn will affect the range of possible future actions. However, this understanding of decision-making remains static in the sense that underlying preferences and values are assumed not to change; neither with the choices people are making, nor with the choices other people are making, or with any other social elements that might change.

Fig. 1.1: Minimalistic illustration of linear decision framework



Note: Simplified illustration of a linear decision framework.

Consequently, standard economics identifies two approaches to achieve a sustainable transformation of society. First, building awareness so that those who have a preference towards protecting the environment and a more sustainable lifestyle will do so. Second, design incentives in a way that sustainable behaviors become the best choice. Clearly, this approach is not helpful when planning infrastructure projects for the next 30 years based on today's preferences (for a discussion see, for example, Mattauch and Hepburn (2016)).

1.2.2 Behavioral economics

Early research in behavioral economics did not strive far beyond this static portrayal of decision-making. Despite pushing to include more realistic assumptions and striving for empirical realism in the field, early research in behavioral economics seemed to be bound by neoclassical assumptions (e.g., fixed preferences unaffected by social elements) and limited to adding parameters to the rational choice model without challenging the

underlying assumptions (Berg and Gigerenzer, 2010). Thus, a key characteristic of early behavioral economics is the representation of behavioral concepts, such as other-regarding preferences, risk aversion, and present biasedness, as a mathematical extension to the rational choice model. On the one hand, this facilitated the acceptance of behavioral insights in the field of economics and made them easier to integrate into existing models. On the other hand, this approach restricted the field of behavioral economics to adhere to as-if assumptions, focusing more on models to predict people's choices than on theories that explain how these choices came to be.

For example, while prospect theory offers more accurate predictions on people's decision-making under risk, the way the theory explains how these decisions are made is nevertheless as unrealistic as the assumption of rational agents in standard economics (Berg and Gigerenzer, 2010, 135-136):

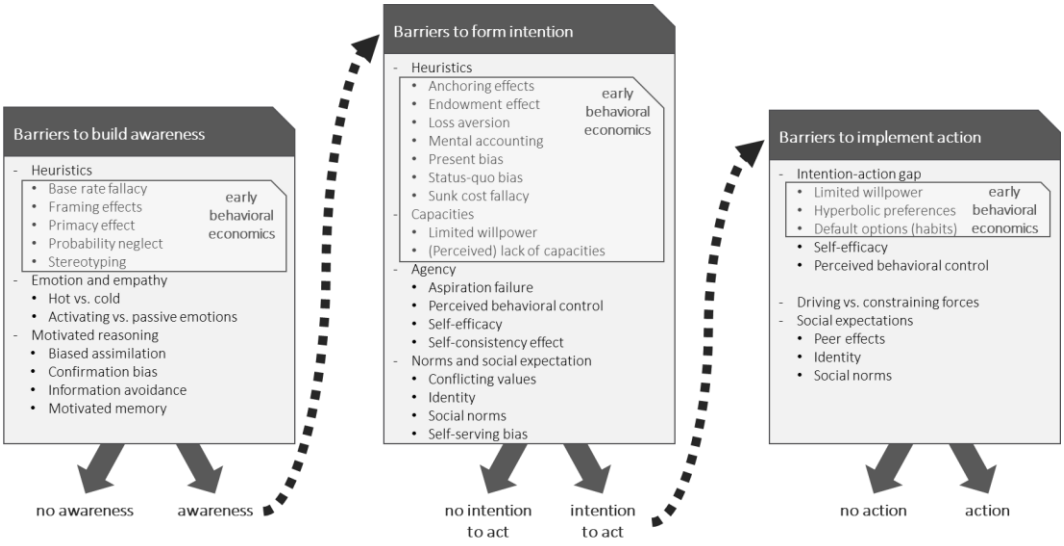
> "According to prospect theory, an individual chooses between lotteries according to the following procedure: First, transform the probabilities of all outcomes associated with a particular lottery using a nonlinear probability-transformation function. Then transform the outcomes associated with that lottery (i.e., all elements of its support). Third, multiply the transformed probabilities and corresponding transformed lottery outcomes, and sum these products to arrive at the subjective value associated with this particular lottery Repeat these steps for all remaining lotteries in the choice set. Finally, choose the lottery with the largest subjective value, computed according to the method above."

Applying the theoretical framework of standard economics, one would expect that building awareness and setting the right incentives would be sufficient for a sustainable transformation of society. Behavioral economics, instead, highlights the existence of biases and behavioral barriers which are inherent to all people that (1) hinder them from forming an accurate awareness of the critical situation of the environment, (2) inhibit the development of adequate intentions to stop the depletion of environmental systems, and finally (3) make it difficult to follow through with intended actions (see Fig. 1.2).

The concept of bounded rationality implies that people would act like rational agents if they could. However, people's mental capacities are limited and therefore they have to rely on mental shortcuts (i.e., heuristics). The idea is that people have two cognitive systems (Kahneman, 2011). One is tireless, quick, and effortless but also emotional, associative, and only slowly changes over time. This system, carrying most of the cognitive workload, is making the vast majority of our decisions without us consciously realizing it. The other system is what we perceive as making conscious and deliberate decisions. It is much slower and takes considerably more effort. However, it is also much more flexible, allowing us to have abstract thoughts, solve complex novel problems, and keep the automatic cognitive system in check. The more we deplete our cognitive resources, the more we fall back relying on our automatic system (Shah et al., 2012). As a result of how

the automatic system tends to work, some well-known biases might be reinforced, for example, people become more loss averse (Kahneman and Tversky, 1979), neglect base rates and overestimate rare events (Tversky and Kahneman, 1992), apply hyperbolic discounting (Laibson, 1997), are affected by endowment effects (Kahneman et al., 1990), and have limited memory (Mullainathan, 2002). Consequently, many interventions proposed by behavioral economics to achieve a sustainable transformation build on the premise of lifting cognitive barriers by simplifying choices and reducing cognitive load. Nudges are specifically designed to steer people towards a specific direction without compromising their freedom of choice (Thaler and Sunstein, 2003). Examples are the employment of timely reminders (e.g., to eat vegetarian), setting default options (e.g., meals are served without meat by default), or manipulation of choice architecture (e.g., highlighting vegetarian options on the menu). While under such interventions individuals are still free to choose, it can help those who intended to implement a certain behavior (eating vegetarian) to realize their intended behavior.

Fig. 1.2: Behavioral barriers in the linear decision framework



Note: Fig. 1.2 illustrates selected barriers identified in behavioral science for why people struggle to build awareness, form intentions, and turn their intentions into actions. Concepts that are part of early research in the field of behavioral economics are highlighted.

While nudges have been successfully implemented as low-cost interventions (Hummel and Maedche, 2019), they mainly seem to work in low-cost situations where environmental concerns have a greater impact on ecological behaviors (e.g., buying unpackaged products) compared to high-cost situations (e.g., buying a new car) where economic incentives seem to dominate environmental attitudes (Diekmann and Preisendörfer, 2003). Thus, recommendations based on early behavioral economics are important complements to building awareness and setting incentives but they are not substitutes. However, even if combined, these interventions are aimed at changing people's behaviors, not establishing new habits and norms (Brandon et al., 2017). Sustainable transformation requires both

short- and long-term behavioral changes, not merely the altering of single actions. By focusing on universal determinants of decision-making (e.g., incentives or cognitive limitations) standard economics and much research in behavioral economics limit the scope of their policy recommendations by abstracting from the social environment within which people live. Yet, people not only struggle to form an accurate awareness because they rely on heuristics but also because, at times, they actively decide to avoid relevant information (Golman et al., 2017) or reason their way to conclusions they favor (Epley and Gilovich, 2016). Additionally, limited willpower is not the only reason why people do not form intentions or struggle to follow-up on them. Instead, this can also be the result of protecting one's identity (Hoff and Pandey, 2014), upholding a social norm (Young, 2015), or because of low self-efficacy and aspiration failures (Cohen et al., 2009, 2006).

By testing behavioral insights in different social and cultural contexts (Heinrichs et al., 2006) and applying them in the field of development economics (Banerjee and Duflo, 2007) it became increasingly clear that the context people live in has a substantial influence on their behavior. Based on behavioral research that has been introduced to economics, we know that social elements can, for example, influence people's visual perception (Segall et al., 1966), spatial cognition (Haun et al., 2011), and reasoning (Nisbett et al., 2001; Talhelm et al., 2014). Culture and other contextual variables shape time and risk preferences (Dohmen et al., 2012; Falk et al., 2018), perception of fairness (Henrich et al., 2010), intrinsic honesty (Gächter and Schulz, 2016), competitiveness (Gneezy et al., 2009), forms of reciprocity (Vollan, 2012), antisocial behavior (Prediger et al., 2014), and the effectiveness of institutions (Prediger et al., 2011; Vollan, 2008; Vollan et al., 2017). Moreover, culture provides a framework for understanding how the world should work, what behaviors are expected from others (Bond and Smith, 1996; Herrmann et al., 2008), what is expected from oneself (Akerlof and Kranton, 2000; Bénabou and Tirole, 2011), the perceived agency to act (Savani et al., 2008), and what is deemed as morally right and wrong (Awad et al., 2018). Thus, this work is not only informative for how context can be adapted to promote sustainable behaviors but it also initiated research informing the components of mental models from an economic perspective.

1.2.3 Insights from other behavioral sciences

The summary above lays out that the current strand of behavioral economics acknowledges the importance of social elements in explaining individual behavior (Hoff and Stiglitz, 2016). These social elements have been applied in other behavioral sciences for some time and have generated a host of models explaining the realization and failure of human behavior. To present a framework that is as meaningful and as up to date as possible, we deem it worthwhile to enhance the insights gained by behavioral economics by these of other behavioral sciences. As a comprehensive review of existing models is

beyond the scope of this chapter, we constrain ourselves to elaborate on a selection of models frequently applied in the realm of sustainable behavior (see Jackson, 2005 for a comprehensive review, and Schlüter et al., 2017 for a systematic evaluation of frameworks).

Arguably, the most prominent theory used for studying human behavior in the realm of sustainability (and behavior in general) is Ajzen's (1991) Theory of Planned Behavior (TPB) and its numerous modified versions. The TPB looks for the explanation of human action in the intention of individuals. Intention, in turn, is argued to be determined by attitude, subjective norms, and perceived behavioral control. Perceived behavioral control is assumed to affect subjective norms, intentions, and actions directly. The TPB has been used to explain human behavior with respect to environmental action such as travel mode choice (Bamberg et al., 2011; Wang et al., 2016), recycling (Ramayah et al., 2012), energy usage (Gao et al., 2017), and green consumption (Yadav and Pathak, 2017; Yuriev et al., 2020).

The unidirectional cause-effect chain running from personal characteristics via intentions towards action unifies the TPB with many theories used to explain human behavior. One advantage of this type of model is that they are easily applicable to empirical research. Cross-sectional data are used to determine correlational relationships between determinants of intention, the intention itself, and action. However, whether the causal chain indeed goes only or at least primarily from intention towards action has been called into question (Kroesen et al., 2017). One limitation of models assuming the cause-effect chain running towards and ending with action is that dynamics such as feedback loops between action, intention, and awareness are neglected.[1]

Whether linear, unidirectional cause-effect models are adequate depends on two factors. The first factor is whether the behavior under consideration is habitual or not. Some actions concerning the environment are of rather singular or infrequent nature, such as buying a new car or house. However, many human activities relevant for sustainability are habitual in nature (Jackson, 2005), such as the mode of transportation from home to work and back, or switching off devices when not in use. Therefore, including habits and the feedback effect of action on habits into the analysis is crucial.

The second differentiation concerns the difference between one specific action and the general behavior. Specific actions are those described above, for example, buying a new car. General behavior may be understood as categories that subsume specific actions. One example are actions that aim at lowering one's CO2 emissions. This general behavior subsumes specific actions such as using energy-saving light bulbs instead of regular ones, commuting by bicycle instead of car, or doing packaging-free instead of plastic intensive shopping. Whenever we are interested in one particular action the linear models will

suffice. However, if we are interested in understanding behavioral change across several actions — that is, the transformation of behavior — we must rely on recursive models incorporating feedback loops. As in this chapter, we aim to provide a framework conceptualizing the change towards more sustainable behavior in general. As such, it is necessary to also include these feedback mechanisms.

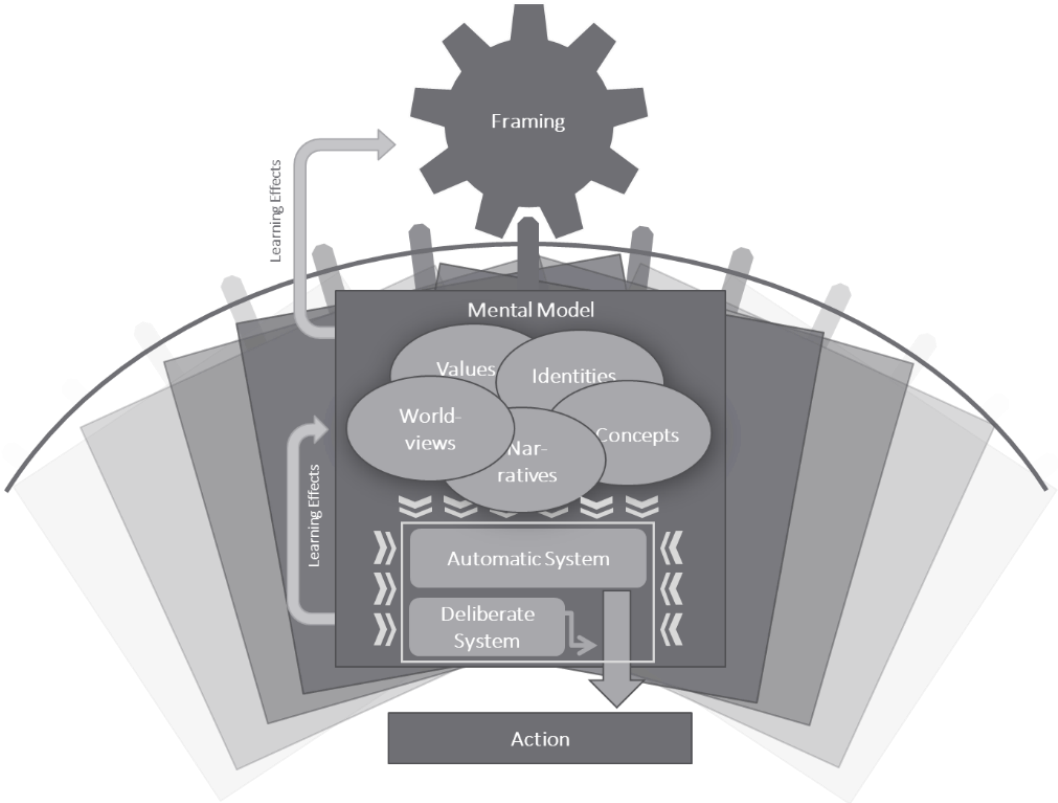
In contrast to the static models presented above, dynamic, or recursive models consider feedback loops by taking into account the crucial role of habits and positive spillovers. One model including habits and the dynamic relationship between habits and behavior more explicitly is the Motivation-Opportunity-Abilities (MOA) model by Ölander and Thøgersen (1995). In this model, the behavior is assumed to have a recursive effect on intention-forming determinants and thereby intention itself. While often cited in articles reviewing approaches to analyze sustainable behavior (Jackson, 2005; Joshi and Rahman, 2015; Steg and Vlek, 2009), MOA did not find great application in empirical studies. This may, however, primarily be the result of the difficulty of applying the framework empirically than the credibility of the mechanism described in the framework. Theoretical (Jackson, 2005) and empirical work (Klöckner, 2013) suggest that habits do play a crucial role in explaining human behavior in the realm of sustainability. However, the empirical application of dynamic models is less straightforward than that of static models. To identify such dynamic relationships panel data are necessary (as in Thøgersen and Ölander, 2003). Both gathering and analyzing panel data is an endeavor posing several challenges. However, due to the importance of feedback effects in explaining transformation of behavior towards sustainability, we consider it vital to include the dynamic effect action has in the analysis of sustainable behavior.

We integrate feedback effects between the single aspects of our conceptual framework following the self-perception theory (SPT) (Bem, 1972). SPT states that individuals derive their self-perception in part by observing their prior actions. Empirical work (Van der Werff et al., 2014) suggests that action in the realm of sustainability does indeed foster a sense of environmental self-identity ultimately affecting environmental intentions. We expand the aspect of self-perception or identity by four more aspects to generate a more complete mental model. In our conceptual framework, we see mental models — tools allowing humans to interpret their surroundings — as a link between actions taken today and the determinants of future actions. For example, choosing an environmentally friendly option might enhance a person's self-perception about caring for the environment which in turn might promote future sustainable choices.

1.3 Integrated model for sustainable transformation

As a starting point, we use Fig. 1.1, which is a simplified illustration resembling static models in behavioral sciences Here, awareness creates intention, which in turn increases the likelihood of an action, that is, the cause-effect chain running horizontally from awareness via intention to action. In Fig. 1.2, we expand this horizontal process by the barriers and drivers to behavioral change identified in behavioral economics. Hence, the realization of the three horizontal factors (awareness, intention, action) is determined by the barriers and driver of each. The formation of intention and action is furthermore affected by whether their corresponding antecedent is realized. While this static framework is helpful to explain the specific functioning of barriers and drivers slowing or pushing action, it does not consider the possibility that individual factors may have a mutually reinforcing effect. Although we collapse the boxes again for better illustration in Fig. 1.3, we still refer to the conceptualization with the underlying barriers and drivers.

Fig. 1.3: Integrated model for behavioral sustainability economics



Note: Fig. 1.3 provides a schematic illustration of how mental models provide the cognitive framework from within people develop their awareness and form intentions to act. Feedback effects from building awareness, forming an intention, and implementing actions are indicated by the arrows. While actions are seen as an outcome, i.e., an observable behavior, they nevertheless influence the mental model as well.

The novelty of the framework presented in Fig. 1.3 is the introduction of dynamic effects via mental models (explained in detail below). As we will argue, dynamic effects between action, intention, and awareness are important for the inquiry of behavioral transformation in the realm of sustainability. These dynamic effects, taking the form of feedback loops,

are mediated by the mental models held by an individual. Put simply, our categories, identities, narratives, and worldviews help us interpret the environment surrounding us affecting ultimately our actions. The awareness we build, intentions we form, and actions we carry out, in turn, affect our mental models. The effect the mental model has on human behavior will be illustrated in the section below. Here we complete the framework by illustrating the last missing step, that is, by illustrating how a specific action can affect the mental model.

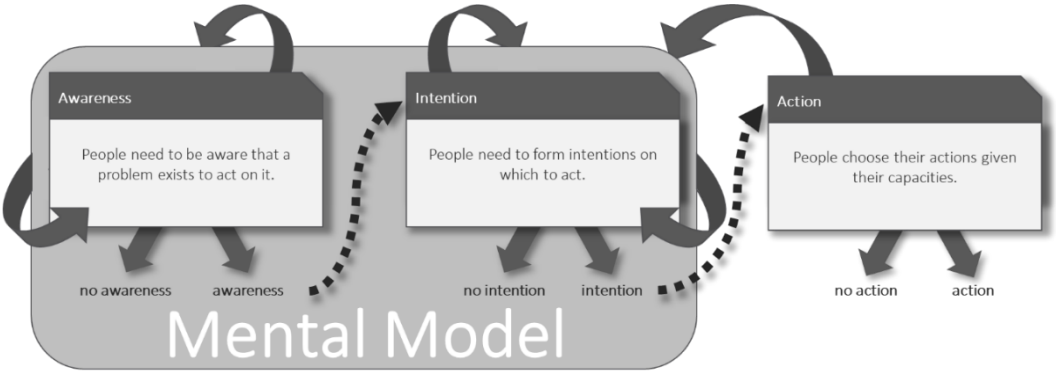
For this, think of a person who decides to use the bike instead of the car to commute to work. Observing oneself giving up comfort for the sake of the climate may foster one's green identity and pride in one's action. Furthermore, it may enhance one's perceived agency by highlighting the possibilities one has to contribute to the mitigation of climate change ultimately altering one's worldview. In turn, environmental awareness and intentions to act may increase. This example illustrates the feedback loop from action towards two dimensions of the mental model (identity and worldview). It can easily be extended to the other three dimensions (categories, narratives, and values). On a more general note, this framework is intended to provide an approach for considering a number of sustainability issues with a focus on individual behavior.

1.3.1 Mental models

First conceptualized by psychologists, the term *mental model* has been prominently introduced into behavioral economics by Hoff and Stiglitz (2016) and the 2015 World Development Report *Mind, Society, and Behavior* (World Bank, 2014). Drawing on Denzau and North (1994) as well as Ostrom (2005), mental models are described as a simplified internal representation of how the world is working and one's place within. "Without mental models of the world, it would be impossible for people to make most decisions in daily life. And without shared mental models, it would be impossible in many cases for people to develop institutions, solve collective action problems, feel a sense of belonging and solidarity, or even understand one another" (World Bank, 2014, p.62). In psychology, sociology, anthropology, and political sciences similar concepts are used to explain behavioral variations over different contexts and cultures; *schemas* and *cognitive frames*, for example, are closely related (DiMaggio, 1997; Markus, 1977). In economics, mental models are considered to include at least five concepts: categories, identities, narratives, values, and worldviews (see Fig. 1.4). These concepts are interconnected and overlapping. For example, social categories play an important part in forming an identity, yet not every category is an identity and identities are more than social categories. Moreover, stereotypes, as a concept would fall into categories but can also be part of a person's identity, narrative, and worldview. This interconnectivity is taken into account by using overlapping circles in Fig. 1.4. While the concepts included are the ones most

studied in economics, there are other concepts and sub-concepts that received more attention in other fields. Thus, our representation should not be seen as final but rather as one way to structure what behavioral economics knows about mental models.

Fig. 1.4: Situational selection of mental model



Note: Fig. 2.4 is an illustrative depiction of how mental models are selected depending on how a situation is framed, i.e., how it is perceived by the individual. Mental models include among others, concepts, identities, values, narratives, and worldviews. It provides the boundaries within the automatic and deliberate system are working. Yet, through experience and deliberate reflection people can develop, adapt, and change their worldviews, narratives, identities, values, and concepts they are using to understand the world around them.

The two cognitive systems, automatic and deliberate Kahneman (2011), function within the mental model. This allows us to distinguish between unconscious behaviors that emerge from the automatic system (e.g., overestimating rare events) and other unconscious behavioral drivers emerging from the mental model (e.g., identity protective cognition). This is important, as consequences from automatic cognition can be circumvented by encouraging deliberate cognition, for example, by providing additional context, offering comparisons, and facilitating understanding using examples and visualizations. Mental models, however, affect both the automatic and deliberate systems. In the case of identity protective cognition, information is disregarded or overstated based on whether it threatens or supports the identity one aims to protect (Bénabou and Tirole, 2011). Thus, to circumvent such behavior, offering more information can be counterproductive. Instead, people should be encouraged to reflect on the identity they want to protect, compare it to other identities and values important to them, and determine whether they want to maintain this behavior or not. Through experience and deliberate reflection, people can develop, adapt, and change their worldviews, narratives, identities, values, and concepts they are using to understand the world around them.

It is important to note that one person can have multiple mental models to draw on in any given situation. Which of the available mental models is activated depends on the situational cues in a given context. The mental model activated will shape how the situation is perceived, what actions are considered, and, ultimately, what choices are made. In economics, this is known as framing effects.

Consider a person driving a car on a hot sunny day. The radio host is talking in vivid language about the impending catastrophe caused by climate change and the importance of individual actions to act against it. That person might be reminded of their self-image as a green person and eventually be more inclined to open the window to reduce the summer sweat than turning up the air conditioner. While an open window may be less effective, it gives the driver the feeling of doing their part by choosing the environmentally friendly option. Now imagine the same person driving their car on a hot summer but listening to the radio host talking about the praising the conveniences that modern technology has provided over time for humanity. That same person might be more likely to turn on the air conditioner instead to fully enjoy the comforts of our time.

Framing effects have been studied extensively and many behavioral interventions make use of them, especially nudges. For example, visual reminders to throw trash in the bin or to wash hands after using the toilet facilitate these behaviors by indicating that it is part of a norm. However, this only works if people are already intrinsically motivated to follow that behavior. It is not possible to nudge someone into doing something if that person does not want to do it.[2]

In the following, we briefly describe each of the five concepts, how they have been applied in behavioral economics and their role in our conceptual framework for behavioral sustainability economics.

1.3.2 Categories

Ideas of categorical thinking and stereotyping have been researched in social psychology for decades (Macrae and Bodenhausen, 2000; Mahon and Caramazza, 2009; Markman and Gentner, 2001). In economics, category-thinking has been applied since the early 2000s (Fryer and Jackson, 2008; Manzini and Mariotti, 2012; Mullainathan et al., 2008), especially in the context of mental accounting (Thaler, 1999) and stereotypes (Bordalo et al., 2016). In economics, the term category has been used to describe how individuals break down the complexity of the real world to cope with the multitude of stimuli and complex social interactions. To save cognitive resources, a host of situations, contexts, or persons are grouped together into categories. These categories help to interpret situations, find adequate reactions and make better choices. For example, while it might be cheaper to have only one bank account to manage savings and expenditures, it is much easier for our brain to divide that one account into separate accounts for specific purposes (e.g., one account to cover rent and electricity bills, one account for long-term savings, another to save money for an upcoming trip, and so forth). While mental categories are an essential part of our cognition, they nevertheless come with obvious downsides of neglecting

potentially important information for the sake of simplicity, creating biased memories, and maintaining discriminating stereotypes.

To achieve sustainable transformation, it is important to rethink what behaviors have been categorized as “good” or “bad” in the mind of the public. For example, increasing household spending and consumption are typically seen as positive as they facilitate economic growth on a societal level and symbolize success on the individual level. However, excessive consumption clashes with the goal of social development within environmental boundaries. Hence, in a sustainable society, unnecessary consumption especially of non-reusable disposable goods should no longer fall into the category of “good” behaviors.

1.3.3 Identities

Identity — as defined in psychology and followed by economics — is a person’s sense of self. This sense of self — who am I and what do I want to be? — is constructed in exchange with the outside world and as a response to it. Every identity is unique in the sense that it is shaped by a person's social context and experiences. This also implies that identities are not fixed but can change over time. The concept of identity has been introduced into economics most prominently by Akerlof and Kranton (2000), arguing that people have identity-based payoffs derived from their own or others’ actions. In behavioral economics, identities have been studied extensively (Akerlof and Kranton, 2010) and applied to studying how religious identities influence behaviors (Benjamin et al., 2016), how identities influence social preferences (Benjamin et al., 2010; Chen and Li, 2009), gender roles (Croson and Gneezy, 2009), cognitive performance (Hoff and Pandey, 2014), and cooperative behaviors (Brooks et al., 2018) among many others.

Identities seem to play an important role in explaining why people perceive the need to drive in big cars, eat meat, take holidays in far-away places, and perceive changes as a threat to their identity. (Dietz and Whitley, 2018) argue that identities strongly influence environmental decision making and play an important part in facilitating a sustainable transformation that is supported by all segments of society.

1.3.4 Values

Values are motivational constructs. They influence behavior not to achieve certain goals but rather to uphold certain standards. While it seems that there is a set of values common to all people around the world, people differ in how they rank the importance of specific values. Like taste receptors, values are ostensibly hardwired into humans yet can change and develop over time (Graham et al., 2013). Johnathan Haidt (2012) argues in *The Righteous Mind* that while we are all born to be righteous, we still have to learn what to be

righteous about. There is plenty of evidence that people around the globe and within societies support different values (Awad et al., 2018) and that these differences shape public discourses and decision-making (Kahan et al., 2011).

Since values are important to a person's self-concept, that is, contributing to a person's sense of identity (Verplanken and Holland, 2002), they play a fundamental part in developing pro-environmental behaviors and establishing norms maintaining them (Farrow et al., 2017). To achieve sustainable transformation, public policy should devote more attention to promoting non-materialistic, egalitarian, and biocentric values (Whitehead, 2014). However, pro-environmental values seem to have a greater impact on pro-environmental actions if these involve little cost in time and money (Diekmann and Preisendörfer, 2003). Moreover, markets have been found to crowd out moral values (Falk and Szech, 2013) and people tend to justify "bad" behaviors with previously "good" acts (Blanken et al., 2015). Thus, promoting pro-environmental values alone is likely not enough to facilitate a sustainable transformation. These values have to be embedded into people's identities and need to be supported by formal and informal norms.

1.3.5 Narratives

Narratives are simplified stories we tell ourselves to explain an event. They specify what elements and processes are related to each other, how to structure and contextualize experiences, predict events, understand power relations, and convey values and social norms (Akerlof and Snower, 2016; Gergen and Gergen, 1988; Nowak et al., 2017). Narratives can be highly illogical and improbable at times, but they are also an essential element of self-structure, shaping the identity of individuals and localities where such stories are being told (Polkinghorne, 1991; Singer, 2004). Thus, narratives do not emerge in isolation but are the product of a complex social world shaped by norms, values, practices, institutions, worldviews, and stereotypes that condition and shape the stories we tell others and ourselves. Importantly, these social realities also affect people's perceived capabilities (i.e., self-efficacy). For example, some environmentally friendly behaviors might not be considered feasible simply because they do not fit the narrative. However, this relationship is also possible in the other direction. Knowing, for example, that a certain behavior (e.g., living without a car) is unfeasible (e.g., no public transportation available), one might choose a narrative that supports the "decision" not to implement that behavior. Ultimately, people have a strong wish to uphold a consistent, meaningful narrative about themselves and the world around them. It is often assumed that people will adapt their behavior once new information emerges. However, it seems that people have to transform information into knowledge first before any behavioral changes can take place. In this process, information is embedded in existing narratives to provide meaning, allowing us to rationalize why specific events do or do not happen (Nowak et al., 2017).

Narratives are not necessarily restricted to personal experiences. They can also emerge from shared experiences, where actors share their observations and stories, merging them into a shared understanding of an event (Bruner, 1990). According to Nowak et al. (2017), individuals may internalize the experiences of others in this process which in turn may influence their decision-making and actions.

In economics, narratives play an increasingly important role even resulting in the emergence of its own sub-field called narrative economics. Especially the creation and spreading of narratives (Bénabou et al., 2019), as well as their impact on the economy and society at large (Shiller, 2020, 2017), have attracted much attention. For achieving sustainable transformation, narratives will play an integral part in conveying why this transformation is needed, communicating the dangers of exceeding planetary boundaries, and embedding the idea that only sustainable growth can lead to lasting prosperity.

1.3.6 Worldviews

In comparison to all other dimensions of the mental model discussed above, worldview is the broadest dimension and overlaps with all others. Worldviews describe how the world works and what one's place is in it. Underlying a worldview is a set of beliefs and assumptions describing the language and symbols to understand the world, express moral values, and provide answers to key questions such as the meaning of life (Johnson et al., 2011; King and Hicks, 2021; Vidal, 2008). Aspiration failures (the failure to reach to one's potential) in the context of poverty is one prominent example of how circumstances (i.e., living in chronic poverty) can shape a people's worldviews (e.g., there is no escape from poverty), which in turn affects their behaviors (e.g., sending children to work instead of school; Dalton et al., 2016). While worldviews have a long-standing tradition in other social sciences (Hedlund-de Witt, 2012; Koltko-Rivera, 2004), they have received much less attention in economics.[3] We speculate that this is due to the difficulties in reliably quantifying worldviews for empirical investigations. Despite this, worldviews seem to gain significantly more attraction recently, especially in ecological economics (Washington and Maloney, 2020).

Establishing an ecological worldview that reflects humanity being part of the natural system and that our behaviors have direct and indirect consequences for that system is an essential part of achieving a sustainable transformation (Beddoe et al., 2009; Wensing et al., 2020). If worldviews do not change, the same patterns of resource exploitation will likely reappear. As Robert Pirsig writes (Pirsig, 1999):

> "If a factory is torn down but the rationality which produced it is left standing, then that rationality will simply produce another factory. If a revolution destroys a systematic government, but the systematic patterns of thought that produced that government are left

> intact, then those patterns will repeat themselves in the succeeding government. There's so much talk about the system. And so little understanding."

Tim N. Jenkins (2002) is among the first economists who used worldviews in connection with sustainability, suggesting to inform western worldviews by Chinese worldviews. He pointed out that, in contrast to the neo-classical paradigms (detached from morality) and enlightenment mentality (separating humanity from nature) in the Western worldview, classical Chinese worldviews seem to be centered around the ideals of harmony, human perfectibility, and systemic fit within natural systems and processes. Although cultural worldviews might not be replaced, nor should they, they can nevertheless be deepened by the introduction of new ideas.

1.4 Conclusions

Historical and current environmental pollution exceeds the planetary boundaries by far. The alarming rate at which environmental degradation is proceeding and the devastating consequences this has for human life make drastic action necessary. As we argued above, we think that behavioral economics has a promising position to contribute to this societal challenge as it can draw on a broad knowledge of the distribution of resources and exploration of motivations of human behavior. The toolbox of economics has been expanded by the continuous development of the field and now includes nudges alongside hard rules and incentives. However, as has been pointed out elsewhere (Beddoe et al., 2009; Capstick et al., 2014; Nisa et al., 2019), these tools are limited in their capability to bring about the transformation necessary to avert climate collapse. The main critique of these approaches is that they only work for as long as they are in place (i.e., do not lead to systemic change) as they do not consider the flexibility of underlying characteristics of individuals but barely take them as given. A new strand of literature reviewed here sheds light on how these characteristics and their alteration can be accounted for in the analysis. However, this inquiry into the deeper roots of human behavior such as categories, identities, narratives, worldviews, and values have been considered only in isolation. A unifying concept and broad recognition of these aspects in the field has been lacking to this point. In our framework, we have synthesized the insights of behavioral economics and enriched them with findings from other behavioral sciences to create a more coherent conceptualization of behavioral transformation relevant to sustainability.

Our goal here was to provide a foundation on which further research within behavioral economics can build. In particular, we highlighted the role of mental models and feedback loops in the study of behavioral transformation in relation to sustainability. While some of these individual connections have been researched to some extent, others have received less attention. Our conceptual framework highlights fruitful avenues for future research.

Feedback effects from action, intention, and awareness towards the single aspects of mental models require further investigation. Understanding the dynamics between behavior and personal characteristics may help to shed light onto when positive spillovers from present action will carry on into the future and how habits affect the realization and failure of behavior.

Research within this field aiming to create a behavioral "big push" will need to differ from existing studies in several ways. First, a wider range of interventions need to be studied and may comprise a set of interventions. Meadows (1999) prominently made the distinction between shallow leverage points (i.e., changing parameters like incentives) and deep leverage points (i.e., changing underlying mind-sets and paradigms) within a system. Her work has received much recent attention (Abson et al., 2017) highlighting that deep system properties, such as worldviews, have been rarely addressed in empirical studies (Dorninger et al., 2020). Second, researching mental models involves more than theoretical mathematical modeling (i.e., neoclassical repair) and deductive quantitative empirical research and calls for applying a mix of methods including *living labs* or *Real-World Laboratories*. Third, both interventions and study designs need a longer time horizon and a focus on spill-over effects.

Beyond highlighting possible avenues for future research, the framework can be applied to evaluate existing policies and deduce new policy recommendations. When evaluating and creating policies, more than the immediate effect on the action itself should be considered. Our framework emphasizes the importance of considering additional effects on underlying factors — i.e., mental models. In this way, an effect beyond the direct radius and duration of the measure can be captured. Furthermore, policies that primarily influence mental models should be considered. This means actively engaging with the categories, identities, values, narratives, and worldviews that people hold. For example, applying self-affirmation interventions to allow identity threatening changes and promoting positive narratives about the future. One area in which comparable approaches are already taken is anti-racist educational work in which participants' ambiguity tolerance is enhanced, helping them to endure cognitive dissonance to reshape persisting categories, identities, narratives, values, and worldviews (see for example the Kreuzberg Initiative against Antisemitism in Berlin, Germany). Such educational work is one possibility to provoke deep-rooted behavioral transformation.

We believe there is a large potential in applying comparable work to the realm of sustainable transformation. Already today, many people consume, vote and behave according to their environmental values, thereby consciously investing more time and money. Future research should focus on the conditions that shape mental models towards more sustainability to bring about deep transformation in the way people perceive the

environment and their role within it. Ultimately, mental models with sustainability at their core would lead people to perceive all decisions through the frame of sustainability prioritizing options that minimize environmental footprint instead of minimizing the price of goods. It is this strong transformation that is needed to avert climate collapse.

1.5 Endnotes

[1] The TPB acknowledges that there could be reverse causality between intention-action but does not consider it explicitly.
[2] For a more detailed discussion see Thaler and Sunstein (2003).
[3] As of the time of writing this chapter, searching for any publications in economics including the word "worldview" at any place in the text search on the Web of Science reveals only 106 publications in total, with 36 publications in public administration, 31 in environmental sciences ecology, 12 in ecology, and 5 Government law.

1.6 References

Abson, D.J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C.D., Jager, N.W., Lang, D.J., 2017. Leverage points for sustainability transformation. Ambio 46, 30–39. https://doi.org/10.1007/s13280-016-0800-y

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.

Akerlof, G.A., Kranton, R.E., 2010. Identity economics. Princeton University Press.

Akerlof, G.A., Kranton, R.E., 2000. Economics and Identity. Q. J. Econ. 115, 715–753. https://doi.org/10.1162/003355300554881

Akerlof, G.A., Snower, D.J., 2016. Bread and bullets. J. Econ. Behav. Organ., Thriving through Balance 126, 58–71. https://doi.org/10.1016/j.jebo.2015.10.021

Awad, E., Dsouza, S., Kim, R., Schulz, J., Henrich, J., Shariff, A., Bonnefon, J.-F., Rahwan, I., 2018. The Moral Machine experiment. Nature 563, 59–64. https://doi.org/10.1038/s41586-018-0637-6

Bamberg, S., Fujii, S., Friman, M., Gärling, T., 2011. Behaviour theory and soft transport policy measures. Transp. Policy 18, 228–235. https://doi.org/10.1016/j.tranpol.2010.08.006

Banerjee, A.V., Duflo, E., 2007. The Economic Lives of the Poor. J. Econ. Perspect. 21, 141–168. https://doi.org/10.1257/jep.21.1.141

Beddoe, R., Costanza, R., Farley, J., Garza, E., Kent, J., Kubiszewski, I., Martinez, L., McCowen, T., Murphy, K., Myers, N., Ogden, Z., Stapleton, K., Woodward, J., 2009. Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. Proc. Natl. Acad. Sci. 106, 2483–2489. https://doi.org/10.1073/pnas.0812570106

Bem, D.J., 1972. Self-Perception Theory, in: Advances in Experimental Social Psychology. Elsevier, pp. 1–62. https://doi.org/10.1016/S0065-2601(08)60024-6

Bénabou, R., Falk, A., Tirole, J., 2019. Narratives, Imperatives, and Moral Reasoning (No. crctr224_2019_070), CRC TR 224 Discussion Paper Series, CRC TR 224 Discussion Paper Series. University of Bonn and University of Mannheim, Germany.

Bénabou, R., Tirole, J., 2011. Identity, Morals, and Taboos: Beliefs as Assets. Q. J. Econ. 126, 805–855. https://doi.org/10.1093/qje/qjr002

Benjamin, D.J., Choi, J.J., Fisher, G., 2016. Religious identity and economic behavior. Rev. Econ. Stat. 98, 617–637.

Benjamin, D.J., Choi, J.J., Strickland, A.J., 2010. Social Identity and Preferences. Am. Econ. Rev. 100, 1913–1928. https://doi.org/10.1257/aer.100.4.1913

Berg, N., Gigerenzer, G., 2010. As-if Behavioral Economics: Neoclassical Economics in Disguise? Hist. Econ. Ideas 18, 133–165.

Blanken, I., van de Ven, N., Zeelenberg, M., 2015. A Meta-Analytic Review of Moral Licensing. Pers. Soc. Psychol. Bull. 41, 540–558. https://doi.org/10.1177/0146167215572134

Bond, R., Smith, P.B., 1996. Culture and conformity: A meta-analysis of studies using Asch's (1952b, 1956) line judgment task. Psychol. Bull. 119, 111–137. https://doi.org/10.1037/0033-2909.119.1.111

Bordalo, P., Coffman, K., Gennaioli, N., Shleifer, A., 2016. Stereotypes. Q. J. Econ. 131, 1753–1794. https://doi.org/10.1093/qje/qjw029

Brandon, A., Ferraro, P.J., List, J.A., Metcalfe, R.D., Price, M.K., Rundhammer, F., 2017. Do The Effects of Social Nudges Persist? Theory and Evidence from 38 Natural Field Experiments (Working Paper No. 23277), Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w23277

Brooks, B.A., Hoff, K., Pandey, P., 2018. Cultural impediments to learning to cooperate: An experimental study of high- and low-caste men in rural India. Proc. Natl. Acad. Sci. 115, 11385–11392. https://doi.org/10.1073/pnas.1804639115

Bruner, J., 1990. Acts of meaning, Acts of meaning. Harvard University Press, Cambridge, MA, US.
Capstick, S., Lorenzoni, I., Corner, A., Whitmarsh, L., 2014. Prospects for radical emissions reduction through behavior and lifestyle change. Carbon Manag. 5, 429–445. https://doi.org/10.1080/17583004.2015.1020011
Chen, Y., Li, S.X., 2009. Group Identity and Social Preferences. Am. Econ. Rev. 99, 431–457. https://doi.org/10.1257/aer.99.1.431
Cohen, G.L., Garcia, J., Purdie-Vaughns, V., Apfel, N., Brzustoski, P., 2009. Recursive Processes in Self-Affirmation: Intervening to Close the Minority Achievement Gap. Science 324, 400–403. https://doi.org/10.1126/science.1170769
Cohen, L.G., Garcia, J., Apfel, N., Master, A., 2006. Reducing the Racial Achievement Gap: A Social-Psychological Intervention. Science 313, 1307–1310. https://doi.org/10.1126/science.1128317
Corner, A., Clarke, J., 2017. Talking Climate. From Research to Practice in Public Engagement. Palgrave Macmillan.
Croson, R., Gneezy, U., 2009. Gender Differences in Preferences. J. Econ. Lit. 47, 448–474. https://doi.org/10.1257/jel.47.2.448
Dalton, P.S., Ghosal, S., Mani, A., 2016. Poverty and Aspirations Failure. Econ. J. 126, 165–188. https://doi.org/10.1111/ecoj.12210
Denzau, A.T., North, D.C., 1994. Shared Mental Models: Ideologies and Institutions. Kyklos 47, 3–31. https://doi.org/10.1111/j.1467-6435.1994.tb02246.x
Diekmann, A., Preisendörfer, P., 2003. Green and Greenback: The Behavioral Effects of Environmental Attitudes in Low-Cost and High-Cost Situations. Ration. Soc. 15, 441–472. https://doi.org/10.1177/1043463103154002
Dietz, T., Whitley, C.T., 2018. Environmentalism, norms, and identity. Proc. Natl. Acad. Sci. 115, 12334–12336. https://doi.org/10.1073/pnas.1817487115
DiMaggio, P., 1997. Culture and Cognition. Annu. Rev. Sociol. 23, 263–287. https://doi.org/10.1146/annurev.soc.23.1.263
Dohmen, T., Falk, A., Huffman, D., Sunde, U., 2012. The Intergenerational Transmission of Risk and Trust Attitudes. Rev. Econ. Stud. 79, 645–677. https://doi.org/10.1093/restud/rdr027
Dorninger, C., Abson, D.J., Apetrei, C.I., Derwort, P., Ives, C.D., Klaniecki, K., Lam, D.P.M., Langsenlehner, M., Riechers, M., Spittler, N., von Wehrden, H., 2020. Leverage points for sustainability transformation: a review on interventions in food and energy systems. Ecol. Econ. 171, 106570. https://doi.org/10.1016/j.ecolecon.2019.106570
Epley, N., Gilovich, T., 2016. The Mechanics of Motivated Reasoning. J. Econ. Perspect. 30, 133–140. https://doi.org/10.1257/jep.30.3.133
Falk, A., Becker, A., Dohmen, T., Enke, B., Huffman, D., Sunde, U., 2018. Global Evidence on Economic Preferences*. Q. J. Econ. 133, 1645–1692. https://doi.org/10.1093/qje/qjy013
Falk, A., Szech, N., 2013. Morals and Markets. Science 340, 707–711. https://doi.org/10.1126/science.1231566
Farrow, K., Grolleau, G., Ibanez, L., 2017. Social Norms and Pro-environmental Behavior: A Review of the Evidence. Ecol. Econ. 140, 1–13. https://doi.org/10.1016/j.ecolecon.2017.04.017
Friedman, M., Savage, L.J., 1948. The Utility Analysis of Choices Involving Risk. J. Polit. Econ. 56, 279–304.
Fryer, R., Jackson, M.O., 2008. A categorical model of cognition and biased decision-making. BE J. Theor. Econ. 8, 1–42.
Gächter, S., Schulz, J.F., 2016. Intrinsic honesty and the prevalence of rule violations across societies. Nature 531, 496–499. https://doi.org/10.1038/nature17160
Gao, L., Wang, S., Li, J., Li, H., 2017. Application of the extended theory of planned behavior to understand individual's energy saving behavior in workplaces. Resour. Conserv. Recycl. 127, 107–113. https://doi.org/10.1016/j.resconrec.2017.08.030
Gergen, K.J., Gergen, M.M., 1988. Narrative and the self as relationship, in: Advances in Experimental Social Psychology. Elsevier, pp. 17–56.
Gigerenzer, G., 2008. Rationality for mortals: How people cope with uncertainty. Oxford University Press.
Gneezy, U., Leonard, K.L., List, J.A., 2009. Gender Differences in Competition: Evidence From a Matrilineal and a Patriarchal Society. Econometrica 77, 1637–1664. https://doi.org/10.3982/ECTA6690
Golman, R., Hagmann, D., Loewenstein, G., 2017. Information Avoidance. J. Econ. Lit. 55, 96–135. https://doi.org/10.1257/jel.20151245
Graham, J., Haidt, J., Koleva, S., Motyl, M., Iyer, R., Wojcik, S.P., Ditto, P.H., 2013. Chapter Two - Moral Foundations Theory: The Pragmatic Validity of Moral Pluralism, in: Devine, P., Plant, A. (Eds.), Advances in Experimental Social Psychology. Academic Press, pp. 55–130. https://doi.org/10.1016/B978-0-12-407236-7.00002-4
Güth, W., 2008. (Non)Behavioral Economics: A Programmatic Assessment. Z. Für Psychol. J. Psychol. 216, 244–253. https://doi.org/10.1027/0044-3409.216.4.244
Haidt, J., 2012. The righteous mind: Why good people are divided by politics and religion. Vintage.
Haun, D.B.M., Rapold, C.J., Janzen, G., Levinson, S.C., 2011. Plasticity of human spatial cognition: Spatial language and cognition covary across cultures. Cognition 119, 70–80. https://doi.org/10.1016/j.cognition.2010.12.009
Hedlund-de Witt, A., 2012. Exploring worldviews and their relationships to sustainable lifestyles: Towards a new conceptual and methodological approach. Ecol. Econ. 84, 74–83.

Heinrichs, N., Rapee, R.M., Alden, L.A., Bögels, S., Hofmann, S.G., Ja Oh, K., Sakano, Y., 2006. Cultural differences in perceived social norms and social anxiety. Behav. Res. Ther. 44, 1187–1197. https://doi.org/10.1016/j.brat.2005.09.006
Henrich, J., Ensminger, J., McElreath, R., Barr, A., Barrett, C., Bolyanatz, A., Cardenas, J.C., Gurven, M., Gwako, E., Henrich, N., Lesorogol, C., Marlowe, F., Tracer, D., Ziker, J., 2010. Markets, Religion, Community Size, and the Evolution of Fairness and Punishment. Science 327, 1480–1484. https://doi.org/10.1126/science.1182238
Herrmann, B., Thöni, C., Gächter, S., 2008. Antisocial Punishment Across Societies. Science 319, 1362–1367. https://doi.org/10.1126/science.1153808
Hoff, K., Pandey, P., 2014. Making up people—The effect of identity on performance in a modernizing society. J. Dev. Econ. 106, 118–131. https://doi.org/10.1016/j.jdeveco.2013.08.009
Hoff, K., Stiglitz, J.E., 2016. Striving for balance in economics: Towards a theory of the social determination of behavior. J. Econ. Behav. Organ., Thriving through Balance 126, 25–57. https://doi.org/10.1016/j.jebo.2016.01.005
Hummel, D., Maedche, A., 2019. How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. J. Behav. Exp. Econ. 80, 47–58. https://doi.org/10.1016/j.socec.2019.03.005
IPCC, 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
Jackson, T., 2005. Motivating Sustainable Consumption. A Review of Evidence on ConsumerBehaviour and Behavioural Change. Sustainable Development Research Network, University of Surrey, Guildford.
Jenkins, T.N., 2002. Chinese traditional thought and practice: lessons for an ecological economics worldview. Ecol. Econ. 40, 39–52. https://doi.org/10.1016/S0921-8009(01)00263-4
John, P., Smith, G., Stoker, G., 2009. Nudge Nudge, Think Think: Two Strategies for Changing Civic Behaviour. Polit. Q. 80, 361–370. https://doi.org/10.1111/j.1467-923X.2009.02001.x
Johnson, K.A., Hill, E.D., Cohen, A.B., 2011. Integrating the Study of Culture and Religion: Toward a Psychology of Worldview: Psychology of Worldview. Soc. Personal. Psychol. Compass 5, 137–152. https://doi.org/10.1111/j.1751-9004.2010.00339.x
Joshi, Y., Rahman, Z., 2015. Factors Affecting Green Purchase Behaviour and Future Research Directions. Int. Strateg. Manag. Rev. 3, 128–143. https://doi.org/10.1016/j.ism.2015.04.001
Kahan, D.M., Jenkins-Smith, H., Braman, D., 2011. Cultural cognition of scientific consensus. J. Risk Res. 14, 147–174. https://doi.org/10.1080/13669877.2010.511246
Kahneman, D., 2011. Thinking, fast and slow. Macmillan.
Kahneman, D., Knetsch, J.L., Thaler, R.H., 1990. Experimental Tests of the Endowment Effect and the Coase Theorem. J. Polit. Econ. 98, 1325–1348. https://doi.org/10.1086/261737
Kahneman, D., Tversky, A., 1979. Prospect Theory: An Analysis of Decision under Risk. Econometrica 47, 263–291. https://doi.org/10.2307/1914185
Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grübler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., III, B.M., O'Riordan, T., work(s):, U.S.R., 2001. Sustainability Science. Sci. New Ser. 292, 641–642.
King, L.A., Hicks, J.A., 2021. The Science of Meaning in Life. Annu. Rev. Psychol. 72, 561–584. https://doi.org/10.1146/annurev-psych-072420-122921
Klöckner, C.A., 2013. A comprehensive model of the psychology of environmental behaviour—A meta-analysis. Glob. Environ. Change 23, 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014
Koltko-Rivera, M.E., 2004. The psychology of worldviews. Rev. Gen. Psychol. 8, 3–58.
Kroesen, M., Handy, S., Chorus, C., 2017. Do attitudes cause behavior or vice versa? An alternative conceptualization of the attitude-behavior relationship in travel behavior modeling. Transp. Res. Part Policy Pract. 101, 190–202. https://doi.org/10.1016/j.tra.2017.05.013
Kurz, T., Gardner, B., Verplanken, B., Abraham, C., 2015. Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. WIREs Clim. Change 6, 113–128. https://doi.org/10.1002/wcc.327
Laibson, D., 1997. Golden Eggs and Hyperbolic Discounting*. Q. J. Econ. 112, 443–478. https://doi.org/10.1162/003355397555253
Lynam, T., Brown, K., 2012. Mental Models in Human–Environment Interactions: Theory, Policy Implications, and Methodological Explorations. Ecol. Soc. 17. https://doi.org/10.5751/ES-04257-170324
Macrae, C.N., Bodenhausen, G.V., 2000. Social Cognition: Thinking Categorically about Others. Annu. Rev. Psychol. 51, 93–120. https://doi.org/10.1146/annurev.psych.51.1.93
Mahon, B.Z., Caramazza, A., 2009. Concepts and Categories: A Cognitive Neuropsychological Perspective. Annu. Rev. Psychol. 60, 27–51. https://doi.org/10.1146/annurev.psych.60.110707.163532
Manzini, P., Mariotti, M., 2012. Categorize Then Choose: Boundedly Rational Choice and Welfare. J. Eur. Econ. Assoc. 10, 1141–1165. https://doi.org/10.1111/j.1542-4774.2012.01078.x
Markman, A.B., Gentner, D., 2001. Thinking. Annu. Rev. Psychol. 52, 223–247. https://doi.org/10.1146/annurev.psych.52.1.223
Markus, H., 1977. Self-schemata and processing information about the self. J. Pers. Soc. Psychol. 35, 63–78. https://doi.org/10.1037/0022-3514.35.2.63
Matson, P., Clark, W.C., Andersson, K., 2016. Pursuing sustainability: a guide to the science and practice. Princeton University Press, Princeton, New Jersey.

Mattauch, L., Hepburn, C., 2016. Climate Policy When Preferences Are Endogenous-and Sometimes They Are. Midwest Stud. Philos. 40, 76–95. https://doi.org/10.1111/misp.12048
Matysková, L., Rogers, B., Steiner, J., Sun, K.-K., 2020. Habits as adaptations: An experimental study. Games Econ. Behav. 122, 391–406. https://doi.org/10.1016/j.geb.2020.04.013
Meadows, D., 1999. Leverage points. Places Interv. Syst. 19.
Meadows, D.H., 2009. Thinking in systems: a primer. Earthscan, London.
Mullainathan, S., 2002. A Memory-Based Model of Bounded Rationality. Q. J. Econ. 117, 735–774. https://doi.org/10.1162/003355302760193887
Mullainathan, S., Schwartzstein, J., Shleifer, A., 2008. Coarse Thinking and Persuasion. Q. J. Econ. 123, 577–619. https://doi.org/10.1162/qjec.2008.123.2.577
Nisa, C.F., Bélanger, J.J., Schumpe, B.M., Faller, D.G., 2019. Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change. Nat. Commun. 10, 4545. https://doi.org/10.1038/s41467-019-12457-2
Nisbett, R.E., Peng, K., Choi, I., Norenzayan, A., 2001. Culture and systems of thought: Holistic versus analytic cognition. Psychol. Rev. 108, 291–310. https://doi.org/10.1037/0033-295X.108.2.291
Nowak, A., Kacprzyk-Murawska, M., Serwotka, E., 2017. Social Psychology and the Narrative Economy, in: Johnson, J., Nowak, A., Ormerod, P., Rosewell, B., Zhang, Y.-C. (Eds.), Non-Equilibrium Social Science and Policy: Introduction and Essays on New and Changing Paradigms in Socio-Economic Thinking, Understanding Complex Systems. Springer International Publishing, Cham, pp. 45–58. https://doi.org/10.1007/978-3-319-42424-8_3
Ölander, F., Thøgersen, J., 1995. Understanding of consumer behaviour as a prerequisite for environmental protection. J. Consum. Policy 18, 345–385. https://doi.org/10.1007/BF01024160
Ostrom, E., 2005. Understanding institutional diversity, Princeton paperbacks. Princeton University Press, Princeton.
Pirsig, R.M., 1999. Zen and the art of motorcycle maintenance: An inquiry into values. Random House.
Polkinghorne, D.E., 1991. Narrative and Self-Concept. J. Narrat. Life Hist. 1, 135–153. https://doi.org/10.1075/jnlh.1.2-3.04nar
Prediger, S., Vollan, B., Frölich, M., 2011. The impact of culture and ecology on cooperation in a common-pool resource experiment. Ecol. Econ., Special Section - Governing the Commons: Learning from Field and Laboratory Experiments 70, 1599–1608. https://doi.org/10.1016/j.ecolecon.2010.08.017
Prediger, S., Vollan, B., Herrmann, B., 2014. Resource scarcity and antisocial behavior. J. Public Econ. 119, 1–9. https://doi.org/10.1016/j.jpubeco.2014.07.007
Ramayah, T., Lee, J.W.C., Lim, S., 2012. Sustaining the environment through recycling: An empirical study. J. Environ. Manage. 102, 141–147. https://doi.org/10.1016/j.jenvman.2012.02.025
Rockström, J., Steffen, W., Noone, K., Persson, \AAsa, Chapin III, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., 2009. Planetary boundaries: exploring the safe operating space for humanity. Ecol. Soc. 14.
Savani, K., Markus, H.R., Conner, A.L., 2008. Let your preference be your guide? Preferences and choices are more tightly linked for North Americans than for Indians. J. Pers. Soc. Psychol. 95, 861–876. https://doi.org/10.1037/a0011618
Schill, C., Anderies, J.M., Lindahl, T., Folke, C., Polasky, S., Cárdenas, J.C., Crépin, A.-S., Janssen, M.A., Norberg, J., Schlüter, M., 2019. A more dynamic understanding of human behaviour for the Anthropocene. Nat. Sustain. 2, 1075–1082. https://doi.org/10.1038/s41893-019-0419-7
Schlüter, M., Baeza, A., Dressler, G., Frank, K., Groeneveld, J., Jager, W., Janssen, M.A., McAllister, R.R.J., Müller, B., Orach, K., Schwarz, N., Wijermans, N., 2017. A framework for mapping and comparing behavioural theories in models of social-ecological systems. Ecol. Econ. 131, 21–35. https://doi.org/10.1016/j.ecolecon.2016.08.008
Segall, M.H., Campbell, D.T., Herskovits, M.J., 1966. The influence of culture on visual perception. Bobbs-Merrill Indianapolis.
Shah, A.K., Mullainathan, S., Shafir, E., 2012. Some Consequences of Having Too Little. Science 338, 682–685. https://doi.org/10.1126/science.1222426
Shiller, R.J., 2020. Narrative Economics, Narrative Economics. Princeton University Press.
Shiller, R.J., 2017. Narrative Economics. Am. Econ. Rev. 107, 967–1004. https://doi.org/10.1257/aer.107.4.967
Singer, J.A., 2004. Narrative identity and meaning making across the adult lifespan: An introduction. J. Pers. 72, 437–460.
Starmer, C., 2005. Normative notions in descriptive dialogues. J. Econ. Methodol. 12, 277–289. https://doi.org/10.1080/13501780500086206
Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: An integrative review and research agenda. J. Environ. Psychol. 29, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004
Talhelm, T., Zhang, X., Oishi, S., Shimin, C., Duan, D., Lan, X., Kitayama, S., 2014. Large-scale psychological differences within China explained by rice versus wheat agriculture. Science 344, 603–608.
Thaler, R.H., 1999. Mental accounting matters. J. Behav. Decis. Mak. 12, 183–206. https://doi.org/10.1002/(SICI)1099-0771(199909)12:3<183::AID-BDM318>3.0.CO;2-F
Thaler, R.H., Sunstein, C.R., 2003. Libertarian Paternalism. Am. Econ. Rev. 93, 175–179. https://doi.org/10.1257/000282803321947001
Thøgersen, J., Ölander, F., 2003. Spillover of environment-friendly consumer behaviour. J. Environ. Psychol. 23, 225–236. https://doi.org/10.1016/S0272-4944(03)00018-5

Tversky, A., Kahneman, D., 1992. Advances in prospect theory: Cumulative representation of uncertainty. J. Risk Uncertain. 297–323.
United Nations, 2019. Climate action and support trends. United Nations Climate Change Secretariat.
Van der Werff, E., Steg, L., Keizer, K., 2014. I Am What I Am, by Looking Past the Present: The Influence of Biospheric Values and Past Behavior on Environmental Self-Identity. Environ. Behav. 46, 626–657. https://doi.org/10.1177/0013916512475209
Verplanken, B., Holland, R.W., 2002. Motivated decision making: Effects of activation and self-centrality of values on choices and behavior. J. Pers. Soc. Psychol. 82, 434–447. https://doi.org/10.1037/0022-3514.82.3.434
Vidal, C., 2008. What is a worldview?, in: De Wetenschappen En Het Creatieve Aspect van de Werkelijkheid.
Vollan, B., 2012. Weird reciprocity? A 'within-culture across-country' trust experiment and methodological implications. J. Institutional Econ. 8, 371–397. https://doi.org/10.1017/S1744137412000033
Vollan, B., 2008. Socio-ecological explanations for crowding-out effects from economic field experiments in southern Africa. Ecol. Econ. 67, 560–573. https://doi.org/10.1016/j.ecolecon.2008.01.015
Vollan, B., Landmann, A., Zhou, Y., Hu, B., Herrmann-Pillath, C., 2017. Cooperation and authoritarian values: An experimental study in China. Eur. Econ. Rev. 93, 90–105. https://doi.org/10.1016/j.euroecorev.2017.01.007
Wang, S., Fan, J., Zhao, D., Yang, S., Fu, Y., 2016. Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. Transportation 43, 123–143. https://doi.org/10.1007/s11116-014-9567-9
Washington, H., Maloney, M., 2020. The need for ecological ethics in a new ecological economics. Ecol. Econ. 169, 106478. https://doi.org/10.1016/j.ecolecon.2019.106478
Wensing, J., Caputo, V., Carraresi, L., Bröring, S., 2020. The effects of green nudges on consumer valuation of bio-based plastic packaging. Ecol. Econ. 178, 106783. https://doi.org/10.1016/j.ecolecon.2020.106783
Whitehead, M., 2014. Environmental transformations: A geography of the Anthropocene. Routledge.
World Bank, 2014. World Development Report 2015: Mind, Society, and Behavior. The World Bank. https://doi.org/10.1596/978-1-4648-0342-0
Yadav, R., Pathak, G.S., 2017. Determinants of Consumers' Green Purchase Behavior in a Developing Nation: Applying and Extending the Theory of Planned Behavior. Ecol. Econ. 134, 114–122. https://doi.org/10.1016/j.ecolecon.2016.12.019
Young, H.P., 2015. The Evolution of Social Norms. Annu. Rev. Econ. 7, 359–387. https://doi.org/10.1146/annurev-economics-080614-115322
Yuriev, A., Dahmen, M., Paillé, P., Boiral, O., Guillaumie, L., 2020. Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review. Resour. Conserv. Recycl. 155, 104660. https://doi.org/10.1016/j.resconrec.2019.104660

2 *Motivated reasoning in the face of sea-level rise*

Matthias Mayer[1†]

Abstract

Motivated reasoning, the tendency to seek and interpret information in ways that confirm preexisting beliefs, values, and identities, is one of the key explanations for why people form polarizing beliefs about climate change. In this study, we present the results of four studies that measured the motivated reasoning of people exposed to varying degrees to sea level rise risks in the United States, Solomon Islands, Bangladesh, and Vietnam. We find strong differences across countries, with the strongest polarization in the United States, followed by Bangladesh, and almost no traces of motivated reasoning in Vietnam. In the Solomon Islands, by contrast, we find no polarization on the topic of SLR, as 68% of respondents exaggerate the risks. Overall, our findings suggest that motivated reasoning may be less the result of cognitive traits or personality types and more likely to be politically conditioned.

Keywords: Motivated reasoning, sea-level rise risks, multiple country evidence

[1] Author affiliation: Department of Economics, Philipps University Marburg, 35032 Marburg, Germany
[†] Correspondence: Matthias Mayer, matthias.mayer@wiwi.uni-marburg.de

Acknowledgments: I would like to thank my colleagues for their valuable feedback and contributions, especially Björn Vollan and Maximilian N. Burger, as well as Moritz Fritschle for his help with data collection in the United States, Abu Siddique for his fieldwork in Bangladesh, and Ivo Steimanis for his assistance in the Solomon Islands. My special thanks go to all the research assistants in Solomon Islands, Bangladesh, and Vietnam, and to the respondents for their participation in our study.

Funding: Research was funded by the Robert Bosch Foundation (Grant number 32.5.F082.0001.0). No competing interests are declared.

***Ethical statement*:** The study design and field implementation were designed and conducted according to the World Medical Association Declaration of Helsinki (2013). All respondents gave their informed consent prior to participating and could withdraw from the study at any time.

Data and materials availability: The surveys, data, and analysis files will be made available after publication.

2.1 Introduction

Climate change is the decisive problem of the Anthropocene. How mankind deals with this global social dilemma will define the 21st century. Motivated reasoning, the tendency to seek and interpret information in ways that confirm preexisting beliefs, values, and identities, is one of the most important explanations for why people form polarizing beliefs about climate change (Hart and Nisbet, 2012). Understanding why people engage in this form of reasoning and finding ways around it is vital for any information-driven society (Dietz, 2013; Eveland and Cooper, 2013; Kahan et al., 2017; Nyhan, 2020), especially with regard to climate change (Druckman and McGrath, 2019; Kahan, 2012). Yet, despite decades of intensive research, no unified theoretical understanding has emerged, let alone effective interventions to mitigate it. The accumulated knowledge is scattered across fields of research and is often too focused on specific subcategories to contribute to the understanding of motivated reasoning as a whole.

We argue that any behavioral theory that aims to explain general human behavior needs to be tested with a sample that is representative of all humanity, not only people living in rich, highly educated, Westernized countries (Henrich et al., 2010). This paper takes a step in that direction by presenting the results of four studies that measured the motivated reasoning of people who are exposed to varying degrees to the risks associated with sea-level rise (SLR) in the United States, Solomon Islands, Bangladesh, and Vietnam. Overall, our findings suggest that motivated reasoning may be less the result of cognitive traits or personality types and more likely to be politically conditioned. In the United States, we find the expected polarization along partisan lines, with one group downplaying SLR risks and the other exaggerating them. In contrast, respondents in the Solomon Islands almost exclusively exaggerated SLR risks, and almost no motivated reasoning was measured in Vietnam. In the Bangladesh study, we find similar patterns of motivated reasoning as in the United States, yet polarization is much stronger in the U.S. This supports Nyhan's (2020) argument that motivated reasoning is more likely to occur when people have weak incentives to hold accurate beliefs and strong directional motivations to endorse beliefs that are consistent with a group identity such as partisanship. Furthermore, Bénabou and Tirole (2016) argue that people are more likely to engage in motivated reasoning when they derive some sort of utility from holding that belief. We find strong evidence for this driver of motivated reasoning in the Solomon Islands, where atoll residents face clear incentives to overstate their vulnerability to SLR to increase the likelihood of receiving much-needed aid.

We developed a flexible measurement design that allows comparing motivated reasoning across multiple topics and contexts. Respondents are presented with two equally true but conflicting pieces of information and asked which (if any) should be ignored by people

like themselves. We adapted the information to the local context of each of the four study sites to ensure that each piece of information was relevant and meaningful to the respondent. Nevertheless, the information pieces always followed the same pattern: one highlighted SLR risks for the local area, and the other highlighted adaptation options or alternative explanations for increased risks of coastal flooding and erosion. We conducted a total of 1,958 surveys with 885 respondents living in coastal and landlocked counties in the United States, 478 living on atoll islands and the much safer Guadalcanal Island in the Solomon Islands, 229 respondents living in the Ganges Delta in Bangladesh, and 366 living in the Mekong Delta in Vietnam. With the exception of most U.S. respondents, all study respondents are highly vulnerable to SLR-related risks and in danger of being displaced in the coming decades or even near future. Therefore, an accurate assessment of these risks could be critical for most respondents in this study to invest in the right adaptation strategies.

The remainder of this study is organized as follows: First, we briefly review the literature on motivated reasoning and illustrate why there is still little consensus on why it occurs and how to prevent it. Second, in the methods section, we provide contextual information about the four study sites, our subjects, and the measurement of motivated reasoning. Third, we present the results for each country, and fourth, we discuss the results and limitations of the study.

2.2 Literature overview

Theories explaining the when, how, and why of motivated reasoning are multifaceted, overlapping, and sometimes contradictory. In this section, we will argue that the reasons for this are twofold. First, research on motivated reasoning is spread across multiple fields, such as economics, psychology, political science, and sociology, often with seemingly little exchange between them. Thus, similar patterns of reasoning are discovered and named differently, which contributes to the field becoming increasingly convoluted. Second, there are many different subcategories of motivated reasoning and several new concepts are discovered or re-discovered every couple of years. Consequently, the wealth of knowledge accumulated by decades of research is often scattered, too specific, and not focused on motivated reasoning as a whole.

Far from being a novel concept, motivated reasoning has been mentioned as early as 431 B.C by the Greek historian Thucydides, who wrote: “[...] their judgment was based more upon blind wishing than upon any sound prevision; for it is a habit of mankind to entrust to careless hope what they long for, and to use sovereign reason to thrust aside what they do not fancy” (Dent, 1910, 4.108.4). The 14th-century Italian poet Dante Alighieri wrote in his Divine Comedy: “opinion — hasty — often can incline to the wrong side, and then

affection for one's own opinion binds, confines the mind" (Dante, 1986, Canto 13, 118-20). In the 17th century, Francis Bacon wrote: "The human understanding when it has once adopted an opinion […] draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects; in order that by this great and pernicious predetermination the authority of its former conclusions may remain inviolate." (Burtt, 1939, p. 36, xlvi). And in the 19th century, Mackay writes in his Extraordinary Popular Delusions and the Madness of Crowds: "When men wish to construct or support a theory, how they torture facts into their service!" (Mackay, 1841/1933, p. 522).

By the mid-20th century, psychologists had already produced a wealth of research revealing various patterns in information processing. For example, the anchoring effect of first impressions and initial hypothesis on the evaluation of subsequent evidence, also called the "primacy effect" was demonstrated by multiple authors (see Rabin and Schrag, 1999): Kelley (1950), for example, showed that people's perception of an individual can be influenced by making small variations in the prior descriptions of that person. Bruner and Potter (1964) presented participants with blurred images that they gradually brought into focus. Participants who started with more blurred images had more difficulty identifying the image, even after the images were sufficiently focused. In contrast, participants who started with sufficiently focused images had no difficulty identifying them. In the study by Jones et al. (1968), participants were asked to rate individuals' problem-solving abilities. Problem solvers who were able to solve many problems right at the beginning were rated as more competent regardless of their later performance. Further, research by Peterson and DuCharme (1967) as well as Pitz, Downing, and Reinhold (1967) provide additional evidence for the "primacy effect".

Early research in psychology has also revealed that people can be blinded by their prejudices and initial theories (Luchins, 1942), evaluate evidence to suit their prior beliefs (Hastorf and Cantril, 1954), and sometimes interpret evidence that should count against their hypothesis as counting in favor of it (Pitz et al., 1967). Based on this research, Lord, Ross, and Lepper (1979) developed their "polarization hypothesis" suggesting that data relevant to one's belief is not processed impartially. "Instead, judgments about the validity, reliability, relevance, and sometimes even the meaning of proffered evidence are biased by the apparent consistency of that evidence with the perceiver's theories and expectations" (p. 2099). Therefore, the authors argue that information in general, but especially mixed or inconclusive evidence, might increase rather than decrease polarization. This hypothesis is further supported by a qualitative review from Frey (1986) and a meta-analysis on voluntary information exposure by Hart et al. (2009), who find a moderate overall preference for congenial information that supports participants' pre-existing attitudes,

beliefs, and behaviors. In addition, this preference for congenial information seems to be more pronounced for strongly held attitudes (Brannon et al., 2007). On a similar note, the theory of cognitive dissonance states that people are motivated to maintain the consistency of their cognitive structure (Festinger, 1957). Attitudes and beliefs that are consistent with other values are therefore more robust to change. There is no lack of potential explanations for why people engage in motivated reasoning to protect previously held beliefs, values, or worldviews. Explanations range from hard-wired biases to various motivations for arriving at a particular conclusion (compare, for example, Bénabou and Tirole, 2016; Kunda, 1990; Nickerson, 1998), to maintain a certain identity (Kahan et al., 2007), or to maintain beliefs associated with membership and status within an identity-defining affinity group whose members are united by shared values and beliefs (Kahan, 2015), among many others.

Motivated reasoning has been studied in its various forms and under different labels, such as attribution error (Clarke, 2002), backfire effect (Nyhan and Reifler, 2010), biased assimilation (Lord et al., 1979), identity protective cognition (Kahan et al., 2007), information avoidance (Golman et al., 2017), moral convictions (Graham et al., 2009), motivated memory (Bower, 1981; Chew et al., 2020), motivated skepticism (Taber and Lodge, 2006), and politically motivated reasoning (Cohen, 2003; Kahan, 2015), to name but a few. This wealth of research on the formation and adaptation of beliefs has led to numerous reviews such as Eveland and Cooper (2013), Kunda (1990), Nickerson (1998), and the Attitudes and Opinion series in the Annual Review of Psychology, which started with Moscovici (1963) and continues with the latest publication by Verplanken and Orbell (2022). For economics, the review by Bénabou and Tirole (2016) is of central importance as it integrates motivated reasoning into the contextual framework of economics by arguing that people hold certain beliefs in part because they receive utility from them. The authors write: “The theory of motivated cognition broadens the purposefulness of human behavior along a variety of dimensions. Some beliefs and emotions are affectively more pleasant than others, like hope and confidence over fear and anxiety. People receive utility from having a positive self-image, and from thinking of themselves as belonging to groups. Optimistic beliefs can also be valuable motivators to overcome self-control problems, as well as helpful in strategic interactions” (Bénabou and Tirole, 2016, pp. 160-1). Golman et al. (2016) further highlight the far-reaching implications of what they call "the preference for belief consonance" for economic behavior. This includes, for example, what media people expose themselves to, who they interact with, what they share information about, and where they live and work.

Based on the literature presented we derive the following three hypotheses to investigate in our four studies:

1. Respondents with strong climate change beliefs will be more likely to engage in motivated reasoning.
2. Exposure to media and other information sources will be a strong predictor of motivated reasoning.
3. Respondents with greater stakes, i.e., those who are more vulnerable to SLR-related risks, will be more likely to engage in motivated reasoning.

Following Kahan et al. (2012) and Drummond and Fischhoff (2017), we additionally examine whether science literacy and numeracy correlate with having polarized beliefs about climate change in the United States. Furthermore, based on the findings of Kahan (2012) and Zmigrod et al. (2021) we investigate if respondents with more dogmatic attitudes are also more likely to engage in motivated reasoning or not.

2.3 Methods

In this section, we describe the four study sites, explain how respondents were recruited, provide a brief description of the sample, and explain how motivated reasoning and other key variables were measured.

2.3.1 Study sites & sampling

The goal of this study is to compare the results of motivated reasoning in the United States with the responses of people whose very livelihoods are threatened by SLR. For this reason, we selected a diverse sample of respondents from the United States and a select sample of respondents living in remote areas considered to be most exposed to risks associated with SLR in the Solomon Islands, Bangladesh, and Vietnam. In the United States, we conducted online surveys in English. In all other studies, surveys were translated into the local languages (Pijin, Bengali, Vietnamese) and conducted using tablets by local interviewers. In each study, the interviewers were trained by us and supervised throughout the data collection process. All respondents were at least 18 years or older at the time of the interview. At the beginning of each interview, informed consent was obtained from all respondents. Data were collected anonymously, and respondents were free to leave and decline to answer at any time.

2.3.1.1 United States

In the United States, were recruited 885 respondents through Amazon MTurk, an online job marketplace provided by Amazon Web Services, in June 2021. Respondents received $1 for completing the survey, which took about 20 minutes. Striving for a mix of respondents from land-locked and coastal counties exposed to SLR risks as well as a mix

of conservative and liberal counties, we invited respondents from Florida, Georgia, Illinois, Indiana, Lousiana, Maine, Michigan, Minnesota, New Hampshire, New York, Ohio, Texas, and Vermont.

2.3.1.2 Solomon Islands

The global sea level is projected to rise by 0.54 to 0.71 meters by the end of the 21st century (Becker et al., 2012; Church et al., 2013). Regionally, however, changes may be up to 20 percent higher in tropical regions (Slangen et al., 2014). Even an increase in sea levels by 10 to 20 cm could already more than double the number of extreme water-level events in the tropics, such as large waves, storm surges, and coastal flooding (Vitousek et al., 2017). Therefore, some researchers conclude that many atoll islands will be uninhabitable by the mid-21st century (Storlazzi et al., 2018).

We conducted 478 surveys in the Solomon Islands at three different study sites between March and June 2017. We interviewed 230 people living on the Reef Islands, a group of atoll islands in Temotu Province, 135 people living on the hills of the capital city Honiara on Guadalcanal, and 113 people who migrated to the capital from atoll islands such as the Reef Islands or Ontong Java and now live in the Reef Island Settlement or the Lord Howe Settlement in Honiara. These settlements were created out of necessity in places that are unattractive to most other people, namely where rivers from the mountains of Guadalcanal flow into the sea. Consequently, these settlements are subject to flooding and threatened by coastal erosion.

In the Reef Islands, we visited all villages with at least 14 households located on one of the many low-lying atoll islands. Our sample includes the villages of Malapu, Malubu, Matema, Ngadeli, Ngawa, Nifiloli, Nola, Pileni, Tanga, and Tuwo. In each village, we created a complete household list from which we randomly selected households for the survey. In Honiara, our goal was to survey Solomon Islands residents least exposed to SLR. Therefore, we excluded all coastal neighborhoods, flood-prone areas, and neighborhoods where more than 60% of residents had recently migrated to Honiara from another island. Therefore, the wards Vavaea, Vuhokesa, and Panatina with 64%, 86%, and 100% migration rates, respectively, were eliminated as potential study sites. In addition, we excluded Rove, sometimes also called Langakiki, because we pretested our survey with people from this ward and our research team stayed in this area for the duration of our research and many people knew us personally. From the remaining wards, we randomly selected four neighborhoods (for details see A.1.1). We created a complete household list for all six research sites in Honiara, the four randomly selected neighborhoods as well as the Lord Howe and Reef Island Settlement. From the result list, we randomly selected households for the survey. Our team of interviewers was instructed to interview the person from the selected households who had the next birthday. If this person was not available,

the person who had a birthday after that was interviewed. In contrast to the other three studies presented here, respondents in the Solomon Islands received no monetary compensation for completing the 30-minute survey. However, our interviewers did offer sweets and refreshments to the respondents as a token of gratitude for taking the time to answer our questions.

2.3.1.3 Bangladesh

Geographic characteristics and population density make the low-lying coastal plain of the Ganges Delta in Bangladesh one of the most vulnerable regions to risks associated with SLR. We interviewed people living in the Barisal Division who are at risk of cyclone-induced coastal flooding, river flooding, tropical storms that typically make landfall at least once a year, riverbank erosion, soil salinization, and droughts that are expected to intensify with rising temperatures (Auerbach et al., 2015; Nicholls et al., 2020). In addition, SLR is expected to increase the severity of coastal flooding during storm surges (Bhuiyan et al., 2012) and tsunamis (Li et al., 2018) and accelerate coastal erosion and salinization (Nicholls and Cazenave, 2010). In the five years prior to our 2018 data collection, Barisal Division was impacted by three severe hurricanes in 2013, 2015, and 2016, and two severe floods in 2014 and 2015 (EM-DAT, 2021). The interviews were conducted in collaboration with the BRAC Institute of Governance and Development (BIGD), which provided experienced interviewers and data on the affectedness of unions in the Barisal Division, which guided our selection of unions from which we randomly selected communities. In total, we interviewed 229 respondents from Amragachhia, Bhandaria, Dapdapia, Padri Shibpur, Roy Pasha Karapur, Shikarpur, and Sholak in the Barisal division in August 2018. The selected rural communities are mainly dependent on agriculture, aquaculture and fisheries and are located between 7 and 39 km from the nearest urban center with more than 100,000 inhabitants.

Respondents were randomly selected following a random walk procedure in each community, where interviewers were given a random starting point from which they headed off in different directions choosing either the left or right side of the street, interviewing a person from every third household, and taking a left turn on every second corner. If a household was not available for the interview or rejected to participate, interviewers were instructed to go to the next household following the same procedure. Respondents were compensated $3.6 for the time it took them to complete the 30-minute survey. Payments were adjusted to the average daily wage of an unskilled worker in Bangladesh and converted using the World Bank's purchasing power parity (PPP) factors to adjust for relative price differences across countries in the purchase of goods and services.

2.3.1.4 Vietnam

Vietnam was ranked 6th place on the Global Climate Risks Index in 2019 (Eckstein et al., 2018), and extreme weather events such as droughts, floods, and high-intensity tropical storms are only expected to increase (Nicholls et al., 2020). The Mekong Delta is particularly exposed to SLR due to its extremely flat topography. Most of the delta is less than 2 meters above the current sea level and, in addition, seems to be sinking. By 2050, land subsidence is expected to range from 0.35 to 1.4 meters on top of an expected SLR of 0.07 to 0.14 meters (Erban et al., 2014). While most typhoons make landfall in northern or central Vietnam, they can have devastating consequences when they make landfall in southern Vietnam. For example, Typhoon Linda in 1997 killed 3,111 people, left 383,000 homeless, and caused an estimated damage of over $385 million (Anh et al., 2017). But the biggest threat comes from floods during storm surges and high tides, coinciding with the monsoon season. Already, water levels can rise by more than one meter during this time, regularly flooding the region (IMHEN, Ca Mau PPC, 2011). In the five years prior to our 2019 data collection, Ca Mau and Bac Lieu provinces were struck by two major floods in 2013 and 2017 (EM-DAT, 2021).

Sampling was conducted by identifying a list of potential research sites based on their exposure to rising sea levels and randomly selecting eight communities from the list of potential sites. In April 2019, we interviewed a total of 366 people from Ca Mau and Bac Lieu provinces. The communities we visited in Dat Mui, Tan An Tay, Nam Can, Cai Nuoc, Dam Doi, Ganh Hao, Nha Mat, Vinh Trach, and Hiep Thanh are largely dependent on agriculture, aquaculture, and fishing. The communities are located between 6 and 77 km from the nearest urban center with more than 100,000 inhabitants. Respondents were randomly selected following a random walk procedure in each community, where interviewers were given a random starting point from which they headed off in different directions choosing either the left or right side of the street, interviewing a person from every third household, and taking a left turn on every second corner. If a household was not available for the interview or rejected to participate, interviewers were instructed to go to the next household following the same procedure. Respondents were compensated $7.3 for the time it took them to complete the 30-minute survey. Payments were adjusted to the average daily wage of an unskilled worker in Vietnam and converted using the World Bank's purchasing power parity (PPP) factors to adjust for relative price differences across countries in the purchase of goods and services.

2.3.2 Sample description

In total, we conducted 1,958 interviews with 885 respondents from the United States, 478 from the Solomon Islands, 229 from Bangladesh, and 366 from Vietnam (Table 2.1). Although we had hoped to obtain a gender balance, the proportion of female respondents

was slightly higher in Vietnam (61%) and slightly lower in Bangladesh (46%) and the Solomon Islands (42%). This is likely an artifact of our sampling strategy. Interviews were conducted during the day, usually between 9 am and 5 pm. In Vietnam, our interviewers were more likely to encounter women who stayed at home than their spouses who worked outside. In the Solomon Islands, in contrast, our interviewers were more likely to encounter men at home. During the day, the women worked in the fields, did laundry, or cooked, while the men, who went fishing early in the morning or in the evening, had much more free time during the day. While there are clear differences in wealth across countries, average household income, adjusted for household size, is much lower in the Solomon Islands than in all other countries. This is because almost half of the respondents in the Solomon Islands live on atoll islands without a cash economy. The average income of respondents living in the capital city of Honiara is much higher than that of atoll residents ($83.52 versus $9.26) and more comparable to the average household income of $110.87 of respondents in Bangladesh. In comparison, respondents from Vietnam are much more wealthy, having an average household income of $360.06 at their disposal.

Table 2.1 Sample overview

	(1) United States	(2) Solomon Islands	(3) Bangladesh	(4) Vietnam	(5) Pooled
VARIABLES	Mean/SD	Mean/SD	Mean/SD	Mean/SD	Mean/SD
Sociodemographics					
Age	40.43	37.37	34.98	44.92	39.88
	[12.66]	[14.21]	[12.14]	[14.12]	[13.61]
Female (=1)	0.50	0.42	0.46	0.61	0.49
	[0.50]	[0.49]	[0.50]	[0.49]	[0.50]
Education (years)	15.13	8.09	7.48	6.37	10.88
	[2.06]	[3.29]	[4.62]	[4.28]	[5.07]
Household income	24,266.82	41.84	110.87	360.06	11,064.48
(pp in $US)	[20,339.60]	[59.34]	[95.52]	[289.95]	[18,192.50]
No. of observations	885	478	229	366	1,958

Notes: Table 2.1 provides a brief overview of the respondents in each study. For a full overview including all recorded variables see supplementary materials A.1.2.

2.3.3 Motivated reasoning measurement

Motivated reasoning was measured by presenting respondents with two pieces of information and asking them if one of the information pieces should be ignored by people like themselves, or not. While we adapted the information pieces to the local context of each of our four studies, they always followed the same pattern. One piece of information highlights the risks of SLR to the local area, particularly coastal erosion and flooding. The other piece of information highlights either adaptation options (United States), erosion resilience of atolls to SLR (Solomon Islands), or increased land accretion due to climate change (Bangladesh). In Vietnam, the only study in which we deviated from this pattern, we contrasted information on SLR risk with the risk of flooding due to land subsidence.

After presenting both information pieces, we asked respondents to indicate on a slider ranging from “the SLR risk information should be completely ignored” on the left-hand side, to “the alternative information should be completely ignored” on the right-hand side and “no information should be ignored” on the center (see supplementary materials A.3). Therefore, this measurement task allows distinguishing between climate change skeptics and climate doomsayers simultaneously, offering them both a piece of information to ignore.

There are several reasons for choosing this design. First, the use of this measurement task ensures transparency in the sense that respondents know directly how their answers will be interpreted. In contrast, if we had asked whether or not to ignore each piece of information on two separate scales, it would have remained unclear to the respondent whether the relative difference between the two scales or the absolute values mattered. Using only one scale eliminates these uncertainties and forces respondents to position themselves on a scale where both researchers and respondents know exactly what the choices mean. Second, to avoid a limiting binary choice between "not ignore" and "ignore," we opted for a scale ranging from 0 "not ignore" to 5 "completely ignore" to allow respondents to better express their opinions. In this way, we can better distinguish between respondents with strong opinions about what information should be ignored and those who lean only slightly in one direction or the other. Third, we chose to ask what other people like themselves should ignore, not what one should ignore oneself. The reason for this decision was that we think that stating that all others should ignore a piece of information is much stronger than deciding only for oneself to ignore that information. It indicates that one's reason for ignoring a piece of information extends to recommending that others should ignore it as well. Therefore, we asked, “considering both pieces of information, which one (if any) do you think [Americans / Solomon Islanders / Bangladeshi / Vietnamese] like you should ignore?” Fourth, we chose to ask what information should be ignored rather than what information is more relevant or important, because respondents' perceived importance and relevance may depend on their preexisting knowledge. For example, for someone who has already accumulated extensive knowledge about SLR, additional information about SLR risks may not be as important as for someone learning about SLR risks for the first time. In addition, the meaning of what is important or relevant may vary from respondent to respondent. To ignore information, however, is a much clearer choice that is also easier to translate into different languages.

2.3.4 Control variables

Climate change beliefs: We asked respondents whether they agreed or disagreed on a 5-point Likert scale with the statements that (i) their country will experience more frequent droughts, (ii) more frequent heavy rains, (iii) increased salinization, (iv) rising sea levels,

and (v) more coastal erosion within the next 5 years. In all four studies, we use the average of these answers as an indicator of whether respondents believe climate change will worsen (α_{us} = .91, α_{si} = .82, α_{bd} = .76, α_{vn}= .84). Belief in climate change conspiracy theories was measured in the United States, Bangladesh, and Vietnam by adopting a modified version from Jolley and Douglas (2014). Respondents were presented with a series of statements, such as "Climate change is a hoax" and "Scientists are spreading panic about climate change because it is in their interest to do so," and asked to indicate their agreement or disagreement with each statement on a 5-point Likert scale. The average over these responses is then used as an indicator for respondents' beliefs in climate change conspiracy theories (α_{us} = .95, α_{bd} = .69, α_{vn} = .90). In the Solomon Islands, belief in climate change conspiracy theories was assessed with an open-ended question. Respondents were classified as believing or not believing in a conspiracy theory depending on their answers. This was because we experienced difficulties in translating the meaning of the term "conspiracy theory" and related questions into Pidgin, the language of most Solomon Islanders. Self-stated climate change knowledge, not recorded in the Solomon Islands, was measured on a 7-point Likert Scale ranging from 1 indicating "I have no idea what climate change is" to 7 "I know exactly what climate change is and how it affects me". In addition, we asked respondents on a scale of 0 "impossible" to 10 "absolutely certain" how likely they think it is that they will have to permanently relocate from their current residence due to flooding and/or erosion. This question was also not recorded in the Solomon Islands.

Information sources: Respondents in our four studies have access to very different sources of information. For example, respondents from the U.S. have access to a much broader range of newspapers, TV channels, websites, and social media compared to atoll residents who at best have access to a radio. We, therefore, had to adapt this measure somewhat to each study site. In the United States, asked respondents how much they trust CNN, BBC, MSNBC, Fox News, or their local news outlets to tell the truth about climate change. Respondents chose a value between 1 "strongly distrust" and 5 "strongly trust" for each news outlet. We then created an index for respondents' average trust in mainstream media and Fox News. In the Solomon Islands, Bangladesh, and Vietnam, we asked the same question yet of a broader range of potential sources of information, including respondents' families, friends, local authorities, and NGOs. The use of principal component analysis (PCA) in each study site reveals two main components, which we label *media* and *social networks*, with the former comprising mainly sources such as television, newspapers, or government officials, and the latter comprising mainly sources such as family, friends, neighbors, school teachers, community leaders, etc. (for further details see A.1.3 supplementary materials).

Political orientation: In Bangladesh and Vietnam, we followed the recommendation of our local partners to refrain from asking any questions regarding politics due to concerns that respondents might be more reluctant to participate or would not answer truthfully. In the Solomon Islands, respondents mainly supported politicians from their home region who were expected to represent their interests in parliament. There also appeared to be a divide between Polynesians and Melanesians, with members of one ethnic group primarily supporting politicians from their ethnic group. This dived, however, did not seem to be central to our research question and therefore we decided not to capture it in our surveys. In the United States, however, political orientation seems to be a determining factor in whether or not people believe in climate change. Therefore, we asked respondents how they politically identify themselves on a scale from 1 "strongly liberal" to 4 "neutral/moderate" and 7 "strongly conservative" including a drop-out option "none/other". We then classified respondents as liberals if they chose values 1 or 2, and as conservatives if they chose values 6 or 7.

Exposure: Respondents' exposure to SLR-associated risks was captured by the Federal Emergency Management Agency's (FEMA) risk rating for each county in the United States. In addition, we also control for coastal vs. land-locked counties and whether the county is led by a Democrat or Republican government. In the Solomon Islands, the main difference in respondents' exposure is due to where they live. Main islanders, people living on the hills of the capital Honiara on Guadalcanal, are less exposed to SLR than atoll residents living on remote, low-lying atolls in Temoto Province. Atoll migrants living directly on the coast in Honiara are less exposed than atoll residents because they can retreat to higher ground in the event of major flooding, but are more exposed than main islanders because they are subject to flooding and threatened by coastal erosion. In Bangladesh and Vietnam, we decided to use respondents' perceived exposure because, while the communities are similarly exposed to SLR risks, individual exposure still varies within each country. Therefore, we asked respondents if they already lost land due to SLR and whether they had to rebuild their homes because of erosion, flooding, or severe storms. Furthermore, we measured the distance to the nearest urban center, assuming that more remote areas are more vulnerable.

Additional control variables (the U.S. only): In the United States, we additionally measure respondents' science literacy by adopting seven survey items from Miller (2004), which were also used in Allum et al. (2008), Drummond and Fischhoff (2017), and Kahan et al. (2012), among others. These questions are binary yes/no questions designed to test respondents' basic scientific knowledge, such as whether the center of the earth is hot or not, whether electrons are smaller than atoms, or whether all radioactivity is caused by humans, for example. The sum of all correct answers results in the science literacy scale ranging from 0 to 7 for each respondent, who achieved an average of 5.7 correct answers.

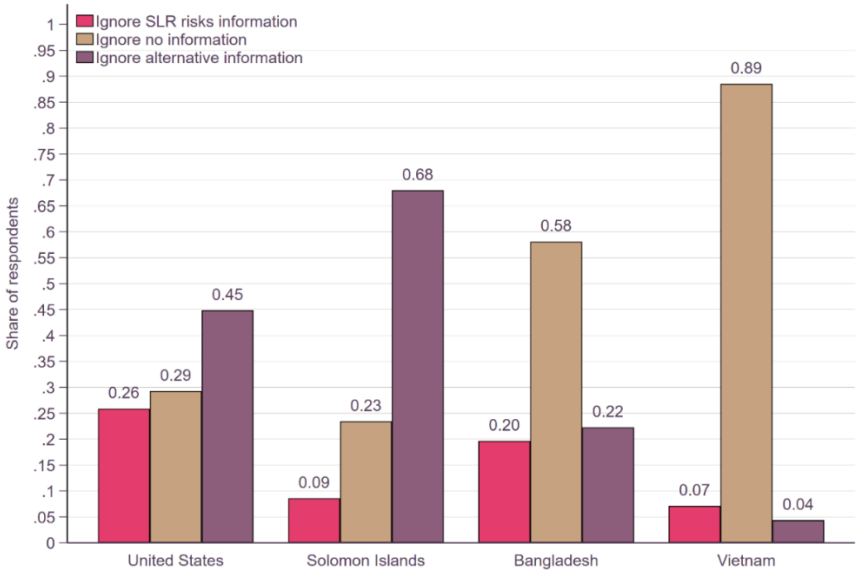
Furthermore, we recorded respondents' basic numeracy skills by adopting a three survey item scale from Lipkus et al. (2001); an extended version of this scale was also used by Kahan et al. (2012). Again, the resulting scale is the sum of all correct answers and ranges from 0, which means that no correct answer was given, to 3, when all questions were answered correctly. On average, respondents answered 2.5 questions correctly. Dogmatism – the tendency to rigidly, uncritically adhere to beliefs – was recorded by adopting a condensed version of Altemeyer's (2002) dogmatism scale. Respondents were presented with nine statements and asked to indicate their opinion on a 7-point Likert scale ranging from 1 " do not agree at all " to 7 "fully agree." Responses are combined into an index by averaging all responses. Higher values are associated with more dogmatic attitudes (α = .840, mean = 3.9). For further details on the variables recorded in each study see A.1.2 supplementary materials.

2.4 Results

In four different studies, we asked respondents if certain information on SLR should be ignored by people like themselves, or not. We compare the responses from the United States, by far the least vulnerable country in our study, with responses from people living in one of the most vulnerable areas to SLR, atoll islands in the Solomon Islands, the Ganges Delta in Bangladesh, and the Mekong Delta in Vietnam. Looking at the share of respondents who stated that no information should be ignored reveals stark differences between Vietnam (89%) and Bangladesh (58%) compared to the United States (29%) and the Solomon Islands (23%), see Fig. 2.1. Respondents from the United States were much more likely to state that the SLR risk information should be ignored compared to all other respondents (T-Test diff. = .154, $t_{1,958}$ = 9.150, $p < .001$), as well as in comparison to respondents from Bangladesh (T-Test diff. = .062, $t_{1,114}$ = 1.951, $p < .052$). The strongest difference, though arguably the most difficult to compare, is seen in the proportion of respondents who said that the alternative information should be ignored, ranging from 68% in the Solomon Islands to 4% in Vietnam. Respondents from the United States were more likely to state that the alternative information should be ignored compared to respondents from Bangladesh and Vietnam (T-Test diff. = .336, $t_{1,480}$ = 14.603, $p < .001$), but not compared to respondents from the Solomon Islands, where 68% stated that the information on non-eroding atolls should be ignored (T-Test diff. = -.173, $t_{1,363}$ = -7.810, $p < .001$). Looking at the share of respondents who stated that no information should be ignored reveals similarly stark differences between Vietnam (89%) and Bangladesh (58%) compared to the United States (29%) and the Solomon Islands (23%). The strongest difference, though arguably the most difficult to compare, is seen in the proportion of

respondents who said that the alternative information should be ignored, ranging from 68% in the Solomon Islands to 4% in Vietnam.

Fig. 2.1 What information should be ignored?



Notes: Fig. 2.1 shows the share of respondents who stated that either the SLR risk information, the alternative information, or no information should be ignored in each study. Respondents were asked, "What information should be ignored by Americans/Solomon Islanders/Bangladeshi/Vietnamese like you?"

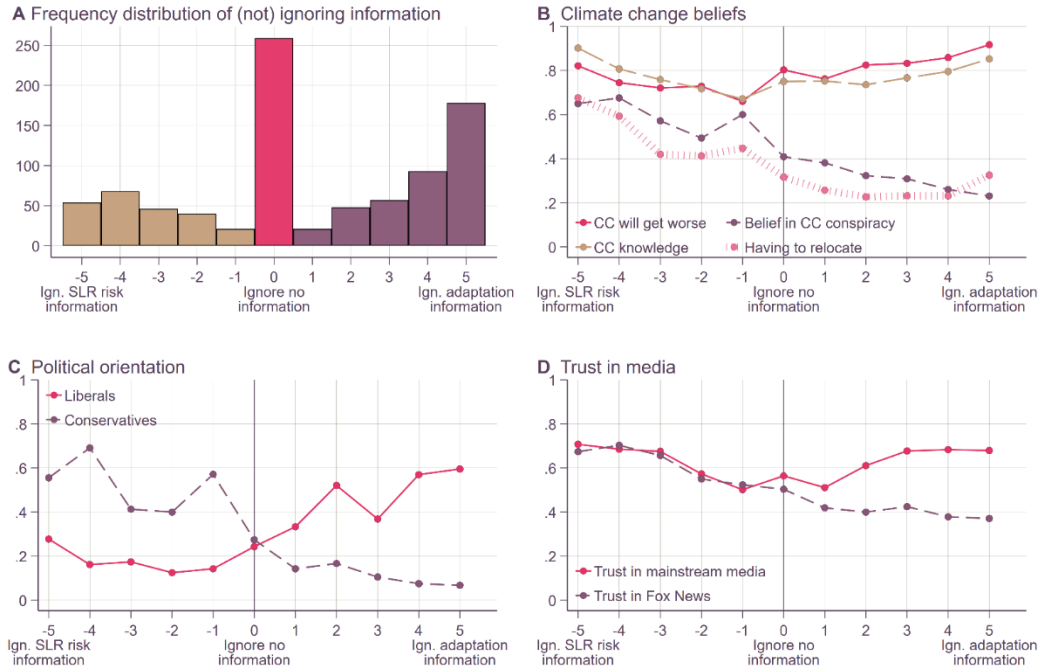
In what follows, we will examine the results of each study for the determinants of (not) ignoring information and the reasons given by respondents for doing so. We will show that motivated reasoning in the face of SLR is expressed in vastly different patterns in the United States, Solomon Islands, and Bangladesh, while it is almost absent in Vietnam. Therefore, the remaining results section is organized as follows. First, we present the results from Study 1 in the United States, where we present information on SLR risk and SLR adaptation to respondents from coastal and landlocked counties. This will serve as a point of comparison for subsequent studies. Second, results are presented from the Solomon Islands, where we presented information on eroding and non-eroding atolls to highly vulnerable residents of extremely remote atolls. Third, we present the findings from the Ganges Delta in Bangladesh where respondents are also highly vulnerable to SLR, but the threat is less evident than in the case of atoll residents. We show respondents information on land erosion and land accretion in the Delta. Both of which are expected to increase with warmer temperatures. Finally, in the fourth section, we show the results from the Mekong Delta in Vietnam, where we show respondents two major risks threatening the delta to disappear into the sea: SLR and land subsidence.

2.4.1 Study 1: United States

While only 6% of the respondents from the U.S. outright denied that climate change exists, 26% (229 out of 885) nevertheless stated that information highlighting the risks of SLR

caused by climate change should be ignored by Americans like themselves (Fig. 2.2A). These respondents are more likely to describe themselves as conservatives (Fig. 2.2C, 54% vs. 16%, T-Test diff. = .26, t_{885} = 12.107, p < .001), trust Fox News to report the truth about climate change (Fig. 2.2D, 64% vs. 43%, T-Test diff. = .21, t_{885} = 45.246, p < .001), and are more likely to believe that climate change is a hoax based on a conspiracy (Fig. 2.2B, 61% vs. 32%, T-Test diff. = .29, t_{885} = 50.213, p < .001). Contradictorily, these respondents are also more likely to believe that they will have to relocate because of rising sea levels (Fig. 2.2B, 53% vs. 29%, T-Test diff. = .24, t_{885} = 47.924, p < .001).

Fig. 2.2 What information should be ignored by Americans like me?



Notes: Fig. 2.2 presents the main outcome variable, that is what information should (not) be ignored, and its relationship to selected key variables. Panel A shows the frequency distribution of the responses provided to the question: What information (if any) should be ignored by Americans like you?" Respondents could select one of the values on the scale ranging from -5 "the SLR risk information should be completely ignored" to 5 "the SLR adaptation information should be completely ignored" with 0 in the center indicating "no information should be ignored." Panel B to D present the average answers given respondents' decision to (not) ignored certain information. All variables are standardized so that the smallest possible value corresponds to 0 and the largest possible value corresponds to 1.

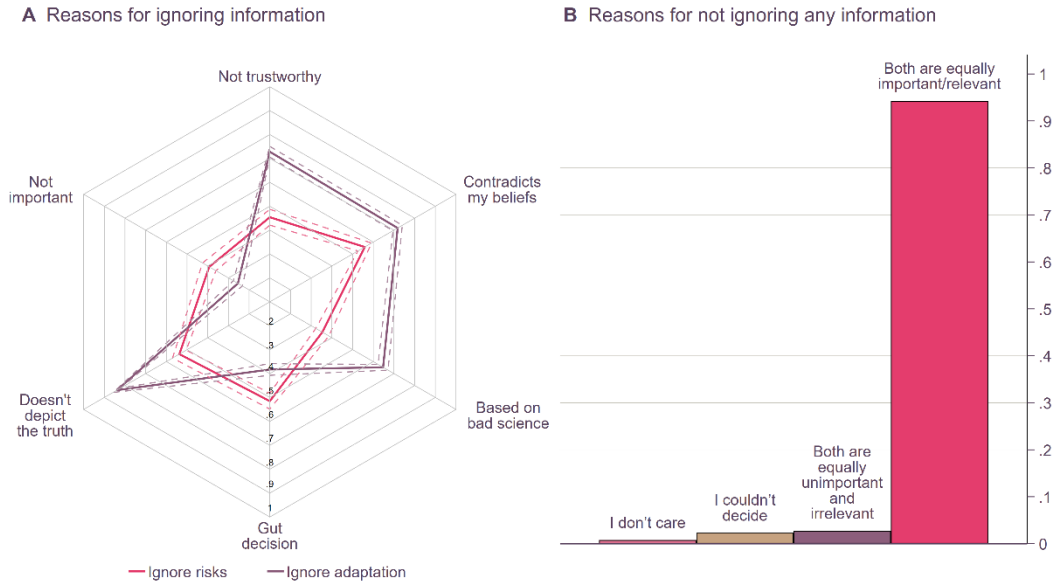
Interestingly, nearly half of all respondents (45%, 397 out of 885) stated that instead of the risks, Americans like themselves should ignore the information that highlights opportunities to adapt to sea level rise (Fig. 2.2A). These respondents are more likely to identify themselves as liberals (Fig. 2.2C, 53% vs. 22%, T-Test diff. = .32, t_{885} = 10.414, p < .001), distrust Fox News (Fig. 2.2D, 39% vs. 57%, T-Test diff. = -.18, t_{885} = -42.966, p < .001), and belief that climate change is not a conspiracy (Fig. 2.2B, 27% vs. 50%, T-Test diff. = -.24, t_{885} = -40.117, p < .001) but instead will get worse (Fig. 2.2B, 87% vs. 78%, T-Test diff. = .10, t_{885} = 32.051, p < .001). Respondents who stated that no information should be ignored (29%, 259 out of 885, Fig. 2.2A) are more cautious about

their self-stated climate change knowledge, reporting on average a lower score than respondents ignoring SLR risk information (Fig. 2.2B, 75% vs. 79%, T-Test diff. = -.04, t_{885} = -9.038, p < .001) or adaptation opportunities (Fig. 2.2B, 75% vs. 80%, T-Test diff. = -.06, t_{885} = -20.708, p < .001).

2.4.1.1 Reasons

When respondents were asked, why they stated that no information should be ignored, 94% (244 out of 259) argued that both pieces of information are equally important and relevant (Fig. 2.3B). In contrast, 39% (90 out of 229) of respondents who stated that SLR risk information should be ignored and 25% (101 out of 397) of those who stated that SLR adaptation information should be ignored explicitly stated that the respective information is not important to Americans like themselves (Fig. 2.3A). In addition, respondents who ignored information about SLR risks argued that the information contradicted their beliefs (56%), did not reflect the true state of the world (54%), did not appear trustworthy (44%), and was based on bad science (35%). And yet 52% reported that their decision was an intuitive gut decision. Looking at the reasons given by respondents who stated that the information on adaptation opportunities should be ignored, we see that 84% said that the information does not reflect the true state of the world, 73% stated that it did not seem trustworthy, 72% that it contradicts their beliefs, and 65% that it is based on bad science. Significantly less respondents said that it was an intuitive gut decision (38% vs. 52%, T-Test diff. = .13, t_{626} = 3.24, p < .002). Overall, respondents ignoring SLR adaptation information named more reasons than respondents ignoring SLR risk information (3.6 vs. 2.8, T-Test diff. = .76, t_{626} = 5.35, p < .001).

Fig. 2.3 Reasons provided for (not) ignoring information



Notes: Fig. 2.3 presents the reasons respondents put forth for why they stated that certain information should (not) be ignored by Americans like themselves. Panel A presents the reasons why the information on SLR risks (pink) and why the information on adaptation opportunities (violet) should be ignored. The center of the graph represents a share of 0 while the outermost line represents a share of 1. The connected lines show the

average share a reason was selected for why the information should be ignored. The dotted lines represent the 95% confidence interval. Panel B presents the reason selected for not ignoring any information. Respondents could select one of the four options presented. The height of the bars shows the share of respondents selecting this reason.

2.4.1.2 Determinants

In the following, we look at the determinants of ignoring information by comparing respondents that stated that the SLR risk information should be ignored (Fig. 2.2A, values -5 to -1) with respondents who stated that no information should be ignored (Fig. 2.2A, value 0). Using ordinary least-square estimations suggests that most of the variance is explained by respondents' climate change beliefs (Table 2.2, column 1, adj. $R^2 = 0.27$). These beliefs are highly interconnected with respondents' political orientation and trust in media outlets (see Table A.7 and Table A.8). Yet, in the combined model (Table 2.2, column 6), only the climate change belief variables remain significant. Furthermore, ignoring SLR risk information strongly correlates with lower numeracy and literacy scores as well as having a more dogmatic mindset. Interestingly, respondents that stated the SLR risk information should be ignored are also more likely to believe that they will have to relocate permanently due to rising sea levels (see Table A.6 for further details). County-level geographical characteristics, such as having a coastline or the FEMA's National Risk Index for coastal flooding in a given county, however, do not correlate with respondents' decisions to ignore SLR risk information.

Table 2.2 Determinants of ignoring SLR in the United States

VARIABLES	(1) Ignore Risks (0-5)	(2) Ignore Risks (0-5)	(3) Ignore Risks (0-5)	(4) Ignore Risks (0-5)	(5) Ignore Risk (0-5)	(6) Ignore Risks (0-5)
Climate change beliefs						
CC will get worse (1-5)	-0.06					-0.11
	(0.11)					(0.11)
Conspiracy (1-5)	0.46***					0.37***
	(0.07)					(0.09)
Knowledge (0-10)	0.18***					0.14***
	(0.04)					(0.04)
Having to relocate (0-10)	0.14***					0.08***
	(0.03)					(0.03)
Information sources						
Trust in mainstream media (1-5)		0.18**				0.15*
		(0.09)				(0.09)
Trust in Fox News (1-5)		0.25***				-0.06
		(0.07)				(0.07)
Political orientation						
Liberal (=1)			0.57***			0.22
			(0.22)			(0.20)
Conservative (=1)			1.21***			0.26
			(0.18)			(0.20)
County variables						
County Gov. Republican (=1)				0.40**		0.21
				(0.18)		(0.16)
FEMA risk rating (0-5)				0.17		0.00
				(0.11)		(0.10)
Coastal county (=1)				-0.29		0.01
				(0.35)		(0.31)

Other control variables						
Numeracy (0-3)					-0.21**	-0.05
					(0.10)	(0.10)
Literacy (1-7)					-0.25***	-0.15**
					(0.07)	(0.07)
Dogmatism (1-7)					0.48***	0.18**
					(0.08)	(0.08)
Constant	-0.83	1.01***	1.93***	2.26***	1.84***	-0.39
	(0.61)	(0.38)	(0.30)	(0.33)	(0.61)	(0.78)
Socioeconomics	yes	yes	yes	yes	yes	yes
Observations	488	488	488	488	488	488
Adjusted R-squared	0.27	0.12	0.14	0.07	0.21	0.30

Note: Table 2.2 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Americans like themselves. The outcome variable ranges from 0 "no information should be ignored" to 5 "SLR risk information should be completely ignored." All regression (1) – (6) control for respondents' age, gender, having a master's degree or higher, and adjusted household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Examining the determinants of ignoring SLR adaptation opportunities further highlights the important role of climate change beliefs, albeit to a lesser extent (Table 2.3, column 1, adj. $R^2 = 0.17$). Ignoring SLR adaptation information correlates with beliefs that climate change will get worse, self-reported knowledge on the subject, and not believing in climate change conspiracy theories. Furthermore, ignoring adaptation information correlates with trusting mainstream media over Fox News, identifying as a liberal instead of a conservative, and higher numeracy and dogmatism scores. County-level control variables are uncorrelated with respondents' decision to ignore SLR adaptation information.

Table 2.3 Determinants of ignoring SLR adaptation in the United States

VARIABLES	(1) Ignore Adapt. (0-5)	(2) Ignore Adapt. (0-5)	(3) Ignore Adapt. (0-5)	(4) Ignore Adapt. (0-5)	(5) Ignore Adapt. (0-5)	(6) Ignore Adapt. (0-5)
Climate change beliefs						
CC will get worse (1-5)	0.33***					0.20*
	(0.11)					(0.11)
Conspiracy (1-5)	-0.61***					-0.38***
	(0.09)					(0.10)
Knowledge (0-10)	0.16***					0.11***
	(0.04)					(0.04)
Having to relocate (0-10)	-0.01					-0.03
	(0.03)					(0.03)
Information sources						
Trust in mainstream media (1-5)		0.63***				0.29***
		(0.07)				(0.08)
Trust in Fox News (1-5)		-0.43***				-0.18**
		(0.06)				(0.07)
Political orientation						
Liberal (=1)			1.11***			0.53***
			(0.17)			(0.18)
Conservative (=1)			-0.83***			-0.24
			(0.22)			(0.23)
County variables						
County Gov. Republican (=1)				-0.08		0.11
				(0.17)		(0.15)
FEMA risk rating (0-5)				0.12		0.03
				(0.12)		(0.12)
Coastal county (=1)				-0.08		0.15

				(0.35)		(0.34)
Other control variables						
Numeracy (0-3)					0.55***	0.35**
					(0.14)	(0.14)
Literacy (1-7)					0.10	-0.03
					(0.07)	(0.07)
Dogmatism (1-7)					0.05	0.15**
					(0.08)	(0.07)
Constant	0.99	1.70***	2.16***	2.59***	0.52	-0.55
	(0.66)	(0.38)	(0.31)	(0.32)	(0.68)	(0.84)
Socioeconomics	yes	yes	yes	yes	yes	yes
Observations	656	656	656	656	656	656
Adjusted R-squared	0.18	0.15	0.13	0.02	0.04	0.23

Note: Table 2.3 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Americans like themselves. The outcome variable ranges from 0 “no information should be ignored” to 5 “SLR adaptation information should be completely ignored.” All regression (1) – (6) control for respondents' age, gender, having a master's degree or higher, and adjusted household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

In summary, we find strong evidence to support the hypothesis that strong beliefs about climate change correlate with motivated reasoning. For example, self-reported knowledge about climate change correlates with both ignoring SLR risks and SLR adaptation opportunities. While believing that climate change will get worse reduces the former and increases the latter, believing in conspiracy theories about climate change has the opposite effect. Furthermore, we find strong evidence for the second hypothesis, that motivated reasoning is connected to media consumption, with trust in mainstream media and FOX news reliably pulling in opposite directions. However, we find no evidence supporting our third hypothesis that respondents who are more vulnerable to SLR-related risks are more likely to engage in motivated reasoning. Throughout all robustness checks, we find no relation between the risk rating assigned to respondents' counties and the likelihood of ignoring either piece of information. The same applies to the distinction between coastal and inland counties (see A.2.1.2 for details).

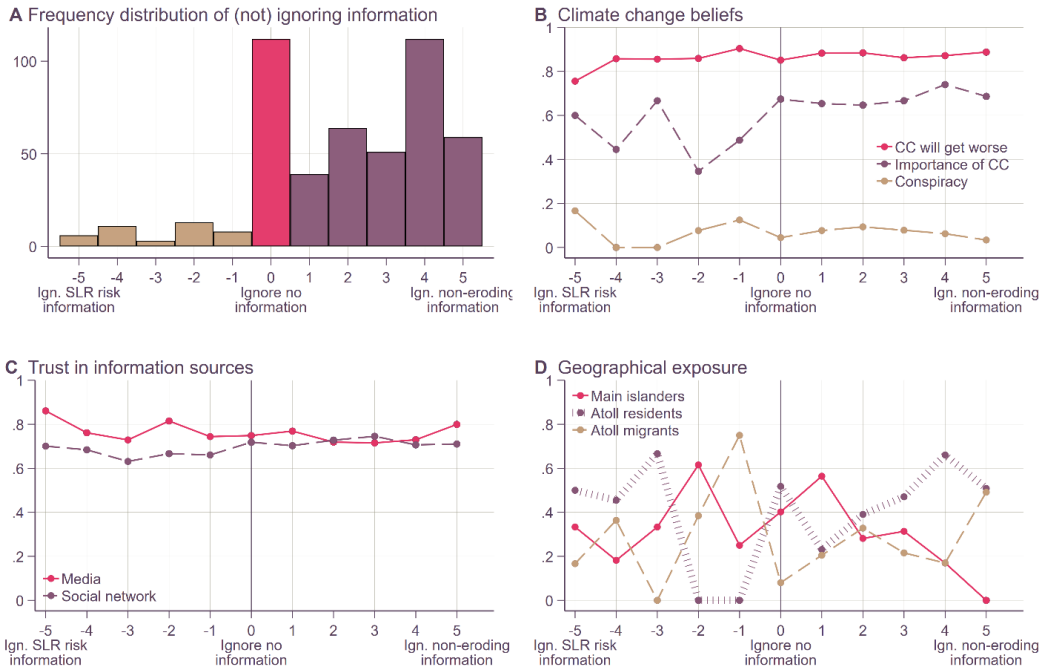
Respondents' political orientation, however, seems to be a far more important predictor of motivated reasoning than exposure to SLR. The polarization between liberal Democrats and conservative Republicans has been studied extensively (Heltzel and Laurin, 2020; Iyengar et al., 2019), and is also reflected here in the interdependence between respondents' beliefs about climate change, the information sources they trust, and, of course, their political orientation. Ultimately, two factions emerge. While one side downplays the impacts of SLR and climate change in the United States, the other exaggerates them. This matters because many of the most influential behavioral studies on information processing are conducted in the United States. Thus, given this polarizing context, one might conclude from studying only people in the United States that it is “normal” for people to polarize on complex issues like climate change. Consequently, to

find underlying reasoning patterns inherent to humans, theories need to be tested in different socio-geographical contexts.

2.4.2 Study 2: Solomon Islands

In the Solomon Islands, only 9% (41 out of 478) of respondents stated that the SLR risk information, specifically the threat of land erosion on atoll islands, should be ignored by Solomon Islanders like themselves (Fig. 2.4A). The vast majority (68%, 325 out of 478) stated that the alternative information, that atoll islands do not necessarily erode when sea levels are rising, should be ignored. The remaining 23% (112 out of 478) reported that no information should be ignored.

Fig. 2.4 What information should be ignored by Solomon Islanders like me?



Notes: Fig. 2.4 presents the main outcome variable, that is what information should (not) be ignored, and its relationship to selected key variables in the Solomon Islands. Panel A shows the frequency distribution of the responses provided to the question: What information (if any) should be ignored by Solomon Islanders like you? Respondents could select one of the values on the scale ranging from -5 "the SLR risk information should be completely ignored" to 5 "the information on non-eroding atolls should be completely ignored" with 0 in the center indicating "no information should be ignored." Panel B to D present the average answers given respondents' decision to (not) ignored certain information. All variables are standardized so that the smallest possible value corresponds to 0 and the largest possible value corresponds to 1.

Respondents from the Solomon Islands certainly believed that climate would get worse in the near future with no significant difference between respondents who stated that the SLR risk information or that no information should be ignored (T-Test diff. = .004, t_{153} = .033, $p < .974$). Only 6% (30 out of 478) of all respondents believed that climate change is part of a conspiracy; not that climate change is made up but rather that it is caused on purpose to harm poor countries. Compared to those who stated that no information should be ignored, respondents who ignore SLR risks reported that climate change plays a less

important role in their lives (T-Test diff. = -2.131, t_{153} = 4.544, p < .001), trust less in their social network (T-Test diff. = -.095, t_{153} = -2.528, p < .013) and trust slightly more in traditional media, such as newspapers, radio, or the television, as reliable sources of information (T-Test diff. = .514, t_{153} = 1.785, p < .076). Looking at respondents' geographical exposure to SLR shows that atoll residents and atoll migrants are much more likely to state that the information that not all atolls will erode due to SLR should be ignored compared to main islanders (T-Test diff. = 1.079, t_{365} = -6.126, p < .001 and T-Test diff. = 1.342, t_{248} = -6.245, p < .001).

In addition, we asked respondents to evaluate each piece of information before being asked if either information should be ignored by Solomon Islanders like themselves. Both pieces of information were perceived as convincing, although the SLR risk information was perceived as slightly more convincing than the information on non-eroding islands (T-Test diff. = .160, t_{478} = 14.214, p < .001). Especially respondents who stated that the information on non-eroding islands should be ignored perceived this information as less convincing (T-Test diff. = -.147, t_{153} = -5.599, p < .001) and as less representative of other atolls in the Solomon Islands (T-Test diff. = -.273, t_{153} = -3.150, p < .002; for further details see A.2.2.1 supplementary materials).

Using ordinary least square estimations and linear probability models, presented in supplementary materials A.2.2.2 for the interested reader, further reveal the importance of geographical exposure to SLR as an explanatory factor for ignoring that information. However, most of the variance remains unexplained using survey data, suggesting that important factors were not captured. Therefore, we will offer some explanations below, based on qualitative data, for why atoll residents and atoll migrants are so much more likely to state that information on non-eroding islands should be ignored.

2.4.2.1 Qualitative evidence from focus group discussions and debriefings

We conducted semi-structured focus group discussions with atoll residents to talk about environmental, social, and economic issues facing their community. A typical discussion lasted up to two hours and consisted of 6 to 10 participants of various age groups and different gender, as well as fishermen, and community leaders. Since we stayed in each village for about two days, we also had many opportunities for spontaneous discussions. During these conversations, the island residents made it clear that they feel neglected by their government. According to them, most of the help they received comes from NGOs, which educated them about climate change and donated solar panels and batteries, water tanks, and helped establish marine protected areas to curb overfishing. In addition, atoll residents seemed to view NGOs as their best hope for investing in their community, such as storm shelters, wells, water tanks, solar energy, fishing nets, or gardening tools. The village chief in Nifiloli told us that he always welcomes foreigners because they usually

bring something good to the community – In our case, it was the influx of cash as we paid for housing, food, and compensated the villagers for participating in our study. Just three months earlier, the chief told us, an NGO came and built them a house with large solar panels and batteries to power a refrigerator for the village. While the people we talked to often linked the help they received from NGOs to their vulnerability to climate change, they often found it difficult to understand why some villages received aid and others did not. In Nagandeli, for example, villagers were surprised that other communities had already received a second large water tank for the village, while they had none. Thus, from the perspective of atoll residents, there seems to be a clear incentive to emphasize their vulnerability to climate change. Given the two pieces of information we presented survey respondents – one stating that atoll islands may be eroded due to SLR, the other stating that they may not – it is therefore not surprising that 70% (162 out of 230) of atoll residents stated that the latter information should be ignored.

What surprised us, however, was that the atoll residents we talked to repeatedly told us how much smaller their islands had become due to SLR. Yet, until our visit in 2017, there had been no large-scale erosion on any of the islands we visited. Thomas Birk (2014) shows using satellite images that the atoll island group we visited did not decline in size between 1971 and 2009 despite an average SLR of over 10mm/year between 1993 and 2009 (Becker et al., 2012). According to Birk's (2014) measurements Nupani, a small island on the outermost reef, even increased in area by over 10%. We presented these satellite pictures in our focus group discussions and asked participants to verify the conclusion drawn that their islands did not get smaller. After some discussion and asking older villagers how they remembered the coastlines, all groups concluded that the pictures were genuine and that their island did actually not get smaller. In the case of Nupani, which we did not visit ourselves, several older fishermen who visited the island frequently confirmed that in their youth the island used to be u-shaped, but the lagoon is now enclosed by vegetated land, leaving only a small lake. In general, the satellite images surprised the people we spoke with, who were often visibly relieved to see that their island had not yet begun to erode.

Certainly, these findings do not mean that these islands are not vulnerable to SLR. Even if the total size of an island does not change, the erosion of fertile, nutrient-rich soil is more detrimental to island communities than the accumulation of sandy soil, on which palm trees can grow but not root and tuber crops. In addition, salinization, i.e., intrusion of saltwater during storms or contamination of groundwater, can also render soil infertile independent of whether the island is getting smaller or not. Thus, we are not claiming that the residents exaggerated their exposure to SLR. The point we are making is that the island residents we spoke to were convinced that their islands were already eroding, even though they were not. Birk (2014) observed this apparent contradiction as well during his 2009/10

fieldwork, writing: "[…] it is possible that some of the interviewees have been affected by discourses of climate change and sea-level rise, and that this has influenced their understanding of the changes they witness and/or the way they present them to outsiders. Although Reef Islands are rarely visited by outsiders (like ourselves), it was evident that some of the people we talked to were aware of the potential threats posed by climate change, as exemplified by the following quote:

> Three men came to the island last year and talked about this climate change and the sea rising. One of them took pictures ... I don't know why. One of these men said that the island will go down in ten years or something like that. So one guy, who is running for parliament this year says that he will find safe land for people elsewhere if we elect him. (Chief, Matema: author's translation – also cited in Birk & Rasmussen, 2012)"

While to some degree this contradiction might result from a demand effect, where atoll residents assume that the interviewer wants to hear about cases of coastal erosion and they are willing to provide such reports. In addition, for atoll residents, coastal erosion could fall into the same category of environmental changes predicted by outsiders due to rising temperatures. Since many of these predictions have come to pass, such as sea level rise, less predictable weather patterns, and more severe storm surges, atoll residents may have concluded that all of the predictions are true, including coastal erosion. However, we suspect that one-sided information exposure plays the largest role. In several conversations, atoll residents stated that they were told by politicians and outsiders, e.g., researchers and people from NGOs, that their islands will be gone soon. Solomon Islands is a member of the Alliance of Small Island States (AOSIS) which represents the interests of 39 small island states severely affected by climate change in international climate negotiations. With the government declaring the country a victim of climate change and even outsiders traveling to the remote atolls to tell the island residents that they are at great risk, it is not a stretch to say that they have been subjected to one-sided reporting. Considering that it also seems to be in their interest to portray themselves as vulnerable, they may have been so focused on the worst predictions and overestimated when they would occur that they believed erosion was already occurring on a large scale, when in fact it was not.

Thus, while we find strong evidence of widespread motivated reasoning in the Solomon Islands, it appears to be driven by very different factors than in the United States. We find no support for our first hypothesis that strong beliefs about climate change increase motivated reasoning. Although, this is probably because almost all respondents believe that climate change will worsen. Regarding the second hypothesis, that information sources are a predictor of motivated reasoning, we find at best unrobust evidence. In contrast, the evidence for the third hypothesis that respondents who are more vulnerable to SLR are more likely to engage in motivated reasoning is exceedingly strong. Atoll

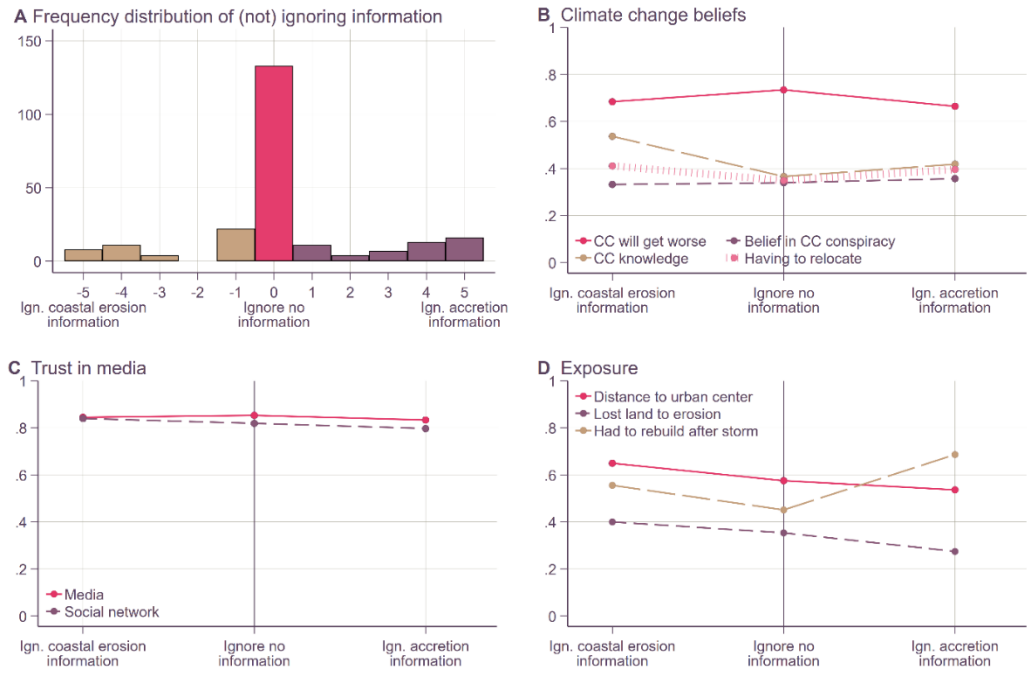
residents and atoll migrants were much more likely to state that the information indicating that atoll islands do not necessarily erode when sea levels rise should be ignored (see supplementary materials A.2.2.2 for details).

2.4.3 Study 3: Bangladesh

In Bangladesh, only 3% (8 out of 229) denied that climate change exists. However, almost 20% (45 out of 229) stated that the information highlighting the exhilarated risk of coastal erosion due to climate change should be ignored by Bangladeshis like themselves. Slightly more, 22% (51 out of 229) stated that the information showing that climate change also increases land accretion should be ignored (Fig. 2.5A). When we asked respondents who most strongly agreed that the erosion or accretion information should be ignored, 87% (20 of 23) and 68% (27 of 40) respectively reported that it was an intuitive gut decision. Nevertheless, the majority of all respondents, (58%, 133 out of 229) stated that no information should be ignored, with 92% (123 out of 133) arguing that both pieces of information are equally important and relevant (for further details on the reasons stated see A.2.3.1 supplementary materials).

Due to the small sample size, only average values for each category of respondent are reported in Fig. 2.5B-D, i.e., those who stated that the coastal erosion information, the land accretion information, or no information should be ignored. Respondents stating that the erosion information should be ignored are slightly less concerned about future climate change events (0.68 vs. 0.73, T-Test diff. = -.05, $t_{178} = -2.054$, $p < .041$) and report a higher self-stated knowledge on the matter (.54 vs. .37, T-Test diff. = .171 $t_{178} = 2.954$, $p < .004$). While respondents stating that the accretion information should be ignored also tend to be less concerned about climate change (.66 vs. .73, T-Test diff. = -.070, $t_{184} = -2.856$, $p < .005$) they are also significantly more likely to report having had to rebuild their home after a severe storm (.69 vs. .45, T-Test diff. = .235, $t_{184} = 2.907$, $p < .005$). These correlations are further supported by linear probability models and least square estimations presented in A.2.3.2 supplementary materials.

Fig. 2.5 What information should be ignored by Bangladeshis like me?



Notes: Fig. 2.5 presents the main outcome variable, that is what information should (not) be ignored, and its relationship to selected key variables. Panel A shows the frequency distribution of the responses provided to the question: What information (if any) should be ignored by Bangladeshis like you?" Respondents could select one of the values on the scale ranging from -5 "the coastal erosion information should be completely ignored" to 5 "the land accretion information should be completely ignored" with 0 in the center indicating "no information should be ignored." Panel B to D present the average answers given respondents' decision to (not) ignored certain information. All variables are standardized so that the smallest possible value corresponds to 0 and the largest possible value corresponds to 1.

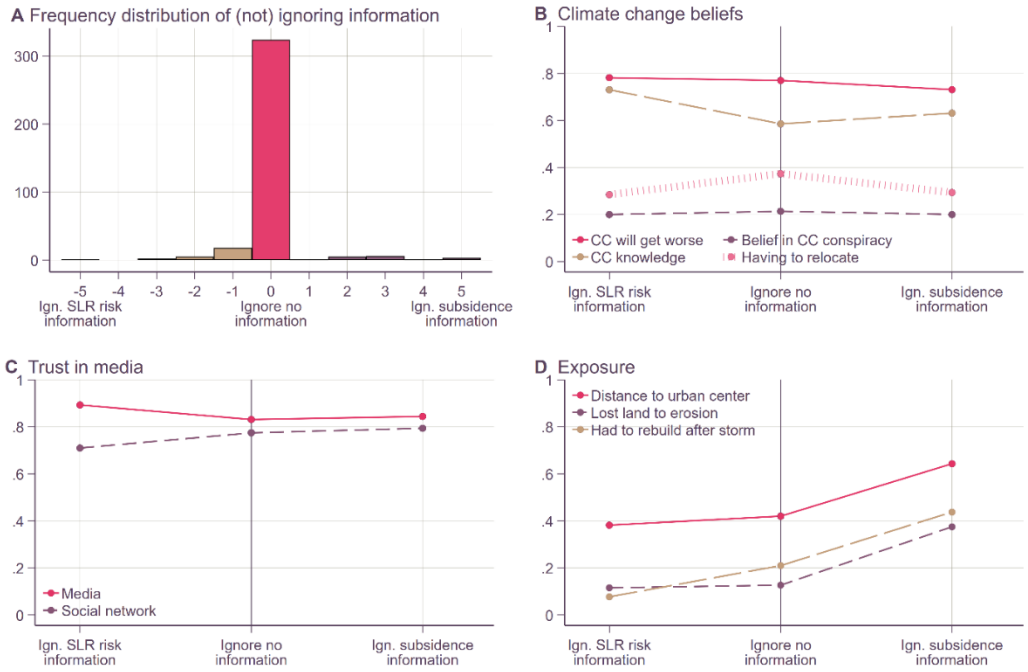
In summary, we find some evidence, albeit not systematic, to support the hypothesis that strong beliefs about climate change increase motivated reasoning, with self-reported knowledge about climate change increasing the likelihood of ignoring information about erosion, and beliefs that climate change is worsening increasing the likelihood of ignoring information about accretion. We find no evidence supporting an association between information sources and motivated reasoning or between respondents' exposure to SLR and motivated reasoning (see supplementary materials A.2.3.2 for details).

2.4.4 Study 4: Vietnam

In the United States, we presented SLR risk and adaptation information. In the Solomon Islands, we presented information on eroding and non-eroding atoll islands. And in Bangladesh, we presented information on land erosion and land accretion exacerbated by SLR. In Vietnam, however, we presented two different explanations for why the Mekong Delta is at risk of disappearing into the sea: (1) the risks of SLR flooding large parts of the low-lying delta and salinating the fertile soil; and (2) the risk of the delta subsiding below sea level due to excessive groundwater extraction.

The vast majority (89%, 324 out of 366) stated that none of the information should be ignored (Fig. 2.6A), with 98% (319 out of 324) arguing that both pieces of information are equally important and relevant. Only 7% (26 out of 366) stated that the SLR risk information should be ignored and 4% (16 out of 366) that the subsidence information should be ignored by Vietnamese like themselves. Only 6% (21 out of 366) of all respondents reported that they do not believe climate change exists and less than 1% (3 out of 366) indicated that they believe in a climate change conspiracy.

Fig. 2.6 What information should be ignored by Vietnamese like me?



Notes: Fig. 2.6 presents the main outcome variable, that is what information should (not) be ignored, and its relationship to selected key variables. Panel A shows the frequency distribution of the responses provided to the question: What information (if any) should be ignored by Vietnamese like you?" Respondents could select one of the values on the scale ranging from -5 "the SLR risk information should be completely ignored" to 5 "the land subsidence information should be completely ignored" with 0 in the center indicating "no information should be ignored." Panel B to D present the average answers given respondents' decision to (not) ignored certain information. All variables are standardized so that the smallest possible value corresponds to 0 and the largest possible value corresponds to 1.

Respondents who stated that the SLR risk information should be ignored reported having a better knowledge of climate change than respondents who stated that no information should be ignored (.73 vs. .59, T-Test diff. = .145, $t_{350} = 2.410$, $p < .017$), have greater trust in the media to report the truth about climate change (.89 vs. .83, T-Test diff. = .062, $t_{350} = 3.376$, $p < .001$), and lower confidence in their social network as a reliable source of information (.71 vs. .77, T-Test diff. = -.064, $t_{350} = -2.746$, $p < .006$). While self-reported climate change knowledge remains barely significant when we control for other variables in the least squares estimates and linear probability models, the difference in trust between the media and the social network remains robust throughout. Respondents who ignored information about ground subsidence tended to live farther from a urban center (.64 vs.

.42, T-Test diff. = .223, $t_{340} = 2.913$, $p < .004$), are more likely to have lost due to erosion (.38 vs. .17, T-Test diff. = .248, $t_{340} = 2.836$, $p < .005$), and were more likely to report that they had to rebuild their home after experiencing a severe storm (.44 vs. .21, T-Test diff. = .228, $t_{340} = 2.152$, $p < .032$). Especially the distance to the next urban center remains a strong indicator for ignoring the land subsidence information once we control for other variables (see supplementary materials A.2.4.2 for details).

Overall, it seems that climate change is a much less controversial issue in Vietnam than in the other study sites. The reason for this might be twofold. First, protecting the Mekong Delta is of immense importance to Vietnam for securing its food security. In addition, as one of the world's leading rice producing and exporting countries, it grows over 50% of its rice in the Mekong Delta (GSO, 2020). During our 2019 visit, we observed major government projects to prevent coastal erosion and investments in flood-proofing infrastructure (A.1.1.2 supplementary materials). Second, Vietnam has launched several programs to promote environmental awareness, reduce littering, and curb pollution in the Mekong Delta (MARD, 2020). In the areas we visited, we also encountered government billboards that urged people to stop littering, start recycling, and protect the environment.

In summary, motivated reasoning in the Vietnam study seems to be minuscule. We find little evidence supporting the first hypothesis the strong beliefs about climate change increase motivated reasoning. Nevertheless, we find some robust evidence to support the hypothesis that motivated reasoning is related to media exposure. Greater trust in the media increases the likelihood of ignoring SLR risk information and trust in one's social network as a reliable source of information decreases this likelihood. Finally, we find the strongest evidence for the third hypothesis, that exposure to SLR correlates with motivated reasoning. The 4% (16 out of 366) of respondents who stated that the information on land subsidence should be ignored also report to be more exposed than other respondents (see A.2.4.2 supplementary materials).

2.5 Discussion

In this study, we present the results of four studies, each measuring motivated reasoning among respondents exposed to SLR to varying degrees. In the United States, we find the expected polarization along partisan lines, with one group downplaying SLR risks and the other exaggerating them. In contrast, respondents in the Solomon Islands almost exclusively exaggerated SLR risks, and almost no motivated reasoning was measured in Vietnam. In the Bangladesh study, we find similar patterns of motivated reasoning as in the United States, but struggle to explain them with the data collected. Overall, the variation in results suggests that the reasons why people engage in motivated reasoning in

the face of SLR risks are multifaceted, complex, and depend on the local socio-political context.

We hypothesized that (1) motivated reasoning would be strongest among respondents with strong beliefs about climate change, (2) that it would correlate with the information sources respondents trust, and (3) that it would be stronger when respondents themselves are exposed to the risks associated with SLR. Overall, we find some evidence for our hypotheses in all four studies (Table 2.4). However, there are many inconsistencies to explore. Respondents from the Solomon Islands, for example, had the strongest beliefs on climate change (4.34 vs. 3.93, T-Test diff. = .434, $t_{1,958}$ = 9.782, $p < .001$), yet only engaged in motivated reasoning to exaggerate the risks of SLR. In Bangladesh, where respondents both downplayed and exaggerated SLR risks, similar to the U.S., our hypotheses seem to work the least. Whereas in Vietnam, where only 11% (42 out of 366) engaged in motivated reasoning our hypotheses seemed to work best.

Table 2.4 Evidence supporting hypotheses

	(1) Strong CC beliefs	(2) Trust in information sources	(3) Vulnerability to SLR
United States	✓	✓	✗
Solomon Islands	✗	(✓)	✓
Bangladesh	✓	✗	✗
Vietnam	(✓)	✓	✓

Notes: Table 2.4 summarizes the evidence we found in each study to support the individual hypotheses. Check marks indicate that evidence was found. Check marks in parentheses signify that we found only weak or limited evidence. And crosses signify that no evidence was found to support this hypothesis.

Bénabou and Tirole (2016) argue that people are more likely to engage in motivated reasoning when they derive some sort of utility from holding that belief. Our findings from the Solomon Islands directly support this. Atoll residents believed that when they emphasize their vulnerability to climate change the chance of them receiving much-needed aid increases. Thus, from this point of view, it seems logical that respondents would state that other Solomon Islanders should ignore the piece of information suggesting that atolls might not necessarily erode with SLR. Furthermore, motivated reasoning is most prevalent in the U.S. where respondents are the least exposed to SLR risks. This supports Nyhan's (2020) argument that motivated reasoning is more likely to occur when people have weak incentives to hold accurate beliefs and strong directional motivations to endorse beliefs that are consistent with a group identity such as partisanship. While 42% (96 out of 229) of respondents in Bangladesh stated that one of the two information pieces should be ignored, only 2 respondents justified their decision by stating that the information was not truthful. In contrast, in the United States, 54% (123 of 229) of respondents who indicated that SLR risk information should be ignored and 84% (333 of 397) of respondents who indicated

that adaptation information should be ignored justified their decision by saying that the respective information was not truthful.

In this study, we applied a survey-based measurement to record motivated reasoning in four very different countries. Although at first glance it may seem that the results would be more comparable if we had kept the information identical across studies, we argue the opposite. Because we conducted the studies in these four countries, the information on adaptation opportunities would have been perceived quite differently across study sites. Very different adaptation strategies are feasible in the U.S. than in Bangladesh, Vietnam, and especially in the Solomon Islands. Consequently, to keep the information identical would have entailed presenting much more generic pieces of information. By adapting the information pieces to the local context of each study site, we ensure measuring motivated reasoning on a topic relevant to the respondents. Out of 1,958 respondents, only 12 stated that the information was unimportant and irrelevant.

Nevertheless, we aimed to keep the pieces of information as similar as possible across the four studies. In the Vietnam study, where we recorded almost no motivated reasoning, the information pieces diverge the most compared to the other studies. In Bangladesh and the Solomon Islands, we focused primarily on erosion hazards, while erosion in the Mekong Delta is a much smaller problem by comparison. Erosion does occur along riverbanks, but the main threat to the delta are flooding and salinization. We, therefore, decided to focus on the SLR and land subsidence and provide respondents with two different explanations for why the Delta is in danger of sinking into the sea. As a consequence of this decision, we expected the rate of motivated reasoning in Vietnam to be higher than in other countries because, unlike all other studies, climate change deniers would not have to claim that there are no SLR risks, but could simply point to land subsidence as the main threat instead, which is caused by excessive groundwater extraction in the delta. Yet, to our surprise, we measured almost no motivated reasoning in Vietnam.

2.6 Conclusion

In this paper, we present findings from four studies measuring motivated reasoning in the face of SLR in the U.S., Solomon Islands, Bangladesh, and Vietnam. Our results reveal stark differences across countries indicating that motivated reasoning is more likely to be politically conditioned than the result of cognitive traits or personality types.

We contribute to the literature on motivated reasoning in general by comparing motivated reasoning patterns across multiple countries. In doing so, we contribute to the exploration of general patterns of reasoning that are common to all mankind and that do not result only from the socio-political context of the United States. Furthermore, we introduce a survey-

based measurement of motivated reasoning that can be easily applied to different subject areas and implemented in studies across countries.

Despite decades of intensive research, there is still no definitive solution to mitigating motivated reasoning, although this is precisely what would be essential for climate communication (see, e.g., Druckman and McGrath, 2019). Future research, therefore, needs to develop an understanding of motivated reasoning patterns that goes beyond the sociopolitical context of the United States, and interventions to mitigate motivated reasoning need to consider the internal drivers, for example, a person's motivation to engage in motivated reasoning, and external drivers, for example, elites who create or amplify misperceptions to influence elections and public policy (see, e.g., see Nyhan, 2020).

2.7 References

Allum, N., Sturgis, P., Tabourazi, D., Brunton-Smith, I., 2008. Science knowledge and attitudes across cultures: A meta-analysis. Public Underst. Sci. 17, 35–54.

Altemeyer, B., 2002. Dogmatic behavior among students: Testing a new measure of dogmatism. J. Soc. Psychol. 142, 713–721. https://doi.org/10.1080/00224540209603931

Anh, L.T., Takagi, H., Thao, N.D., Esteban, M., 2017. Investigation of Awareness of Typhoon and Storm Surge in the Mekong Delta – Recollection of 1997 Typhoon Linda. J. Jpn. Soc. Civ. Eng. Ser B3 Ocean Eng. 73, I_168-I_173. https://doi.org/10.2208/jscejoe.73.I_168

Auerbach, L.W., Goodbred Jr, S.L., Mondal, D.R., Wilson, C.A., Ahmed, K.R., Roy, K., Steckler, M.S., Small, C., Gilligan, J.M., Ackerly, B.A., 2015. Flood risk of natural and embanked landscapes on the Ganges–Brahmaputra tidal delta plain. Nat. Clim. Change 5, 153–157.

Becker, M., Meyssignac, B., Letetrel, C., Llovel, W., Cazenave, A., Delcroix, T., 2012. Sea level variations at tropical Pacific islands since 1950. Glob. Planet. Change 80–81, 85–98. https://doi.org/10.1016/j.gloplacha.2011.09.004

Bénabou, R., Tirole, J., 2016. Mindful Economics: The Production, Consumption, and Value of Beliefs. J. Econ. Perspect. 30, 141–164. https://doi.org/10.1257/jep.30.3.141

Bhuiyan, M., Naser, J.A., Dutta, D., 2012. Analysis of flood vulnerability and assessment of the impacts in coastal zones of Bangladesh due to potential sea-level rise. Nat. Hazards 61, 729–743.

Birk, T., 2014. Assessing vulnerability to climate change and socioeconomic stressors in the Reef Islands group, Solomon Islands. Geogr. Tidsskr.-Dan. J. Geogr. 114, 59–75. https://doi.org/10.1080/00167223.2013.878228

Bower, G.H., 1981. Mood and memory. Am. Psychol. 36, 129–148. https://doi.org/10.1037/0003-066X.36.2.129

Brannon, L.A., Tagler, M.J., Eagly, A.H., 2007. The moderating role of attitude strength in selective exposure to information. J. Exp. Soc. Psychol. 43, 611–617. https://doi.org/10.1016/j.jesp.2006.05.001

Bruner, J.S., Potter, M.C., 1964. Interference in visual recognition. Science 144, 424–425.

Burtt, E.A., 1939. The English Philosophers: From Bacon to Mill. New York: The Modern Library.

Chew, S.H., Huang, W., Zhao, X., 2020. Motivated False Memory. J. Polit. Econ. 128, 3913–3939. https://doi.org/10.1086/709971

Church, J.A., Clark, P.U., Cazenave, A., Gregory, J.M., Jevrejeva, S., Levermann, A., Merrifield, M.A., Milne, G.A., Nerem, R.S., Nunn, P.D., 2013. Sea-level rise by 2100. Science 342, 1445–1445.

Clarke, S., 2002. Conspiracy Theories and Conspiracy Theorizing. Philos. Soc. Sci. 32, 131–150. https://doi.org/10.1177/004931032002001

Cohen, G.L., 2003. Party Over Policy: The Dominating Impact of Group Influence on Political Beliefs. J. Pers. Soc. Psychol. 85, 808–822. https://doi.org/10.1037/0022-3514.85.5.808

Dante, A., 1986. Paradiso. Bantam Classics; Reissue edition (January 1, 1986).

Dent, J.M., 1910. Thucydides: The Peloponnesian War. N. Y. EP Dutton.

Dietz, T., 2013. Bringing values and deliberation to science communication. Proc. Natl. Acad. Sci. 110, 14081–14087. https://doi.org/10.1073/pnas.1212740110

Druckman, J.N., McGrath, M.C., 2019. The evidence for motivated reasoning in climate change preference formation. Nat. Clim. Change 9, 111–119. https://doi.org/10.1038/s41558-018-0360-1

Drummond, C., Fischhoff, B., 2017. Individuals with greater science literacy and education have more polarized beliefs on controversial science topics. Proc. Natl. Acad. Sci. 114, 9587–9592.

Eckstein, D., Hutfils, M.-L., Winges, M., Germanwatch, 2018. Global Climate Risk Index 2019 Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2017 and 1998 to 2017.

EM-DAT, 2021. The CRED/OFDA International Disaster Database.
Erban, L.E., Gorelick, S.M., Zebker, H.A., 2014. Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Vietnam. Environ. Res. Lett. 9, 084010. https://doi.org/10.1088/1748-9326/9/8/084010
Eveland, W.P., Cooper, K.E., 2013. An integrated model of communication influence on beliefs. Proc. Natl. Acad. Sci. 110, 14088–14095. https://doi.org/10.1073/pnas.1212742110
Festinger, L., 1957. A theory of cognitive dissonance. Evanston, IL: Row, Peterson. Festinger, L.(1964). Conflict, decision, and dissonance. Stanford, CA: Stanford University.
Frey, D., 1986. Recent Research on Selective Exposure to Information, in: Berkowitz, L. (Ed.), Advances in Experimental Social Psychology. Academic Press, pp. 41–80. https://doi.org/10.1016/S0065-2601(08)60212-9
Golman, R., Hagmann, D., Loewenstein, G., 2017. Information Avoidance. J. Econ. Lit. 55, 96–135. https://doi.org/10.1257/jel.20151245
Golman, R., Loewenstein, G., Moene, K.O., Zarri, L., 2016. The Preference for Belief Consonance. J. Econ. Perspect. 30, 165–188. https://doi.org/10.1257/jep.30.3.165
Graham, J., Haidt, J., Nosek, B.A., 2009. Liberals and conservatives rely on different sets of moral foundations. J. Pers. Soc. Psychol. 96, 1029–1046. https://doi.org/10.1037/a0015141
GSO, 2020. Statistical Summary Book of Viet Nam 2018, Statistical Handbook. General Statistics Office, Ha Noi.
Hart, P.S., Nisbet, E.C., 2012. Boomerang Effects in Science Communication: How Motivated Reasoning and Identity Cues Amplify Opinion Polarization About Climate Mitigation Policies. Commun. Res. 39, 701–723. https://doi.org/10.1177/0093650211416646
Hart, W., Albarracín, D., Eagly, A.H., Brechan, I., Lindberg, M.J., Merrill, L., 2009. Feeling validated versus being correct: A meta-analysis of selective exposure to information. Psychol. Bull. 135, 555–588. https://doi.org/10.1037/a0015701
Hastorf, A.H., Cantril, H., 1954. They saw a game; a case study. J. Abnorm. Soc. Psychol. 49, 129.
Heltzel, G., Laurin, K., 2020. Polarization in America: two possible futures. Curr. Opin. Behav. Sci., Political Ideologies 34, 179–184. https://doi.org/10.1016/j.cobeha.2020.03.008
Henrich, J., Heine, S.J., Norenzayan, A., 2010. The weirdest people in the world? Behav. Brain Sci. 33, 61–83. https://doi.org/10.1017/S0140525X0999152X
IMHEN, Ca Mau PPC, 2011. Climate Change Impact and Adaptation Study in the Mekong Delta Ca Mau Atlas. Institute of Meteorology, Hydrology and Environment (IMHEN), Ha Noi, Vietnam.
Iyengar, S., Lelkes, Y., Levendusky, M., Malhotra, N., Westwood, S.J., 2019. The Origins and Consequences of Affective Polarization in the United States. Annu. Rev. Polit. Sci. 22, 129–146. https://doi.org/10.1146/annurev-polisci-051117-073034
Jolley, D., Douglas, K.M., 2014. The social consequences of conspiracism: Exposure to conspiracy theories decreases intentions to engage in politics and to reduce one's carbon footprint. Br. J. Psychol. 105, 35–56. https://doi.org/10.1111/bjop.12018
Jones, E.E., Rock, L., Shaver, K.G., Goethals, G.R., Ward, L.M., 1968. Pattern of performance and ability attribution: An unexpected primacy effect. J. Pers. Soc. Psychol. 10, 317.
Kahan, D.M., 2015. The politically motivated reasoning paradigm. Emerg. Trends Soc. Behav. Sci. Forthcom.
Kahan, D.M., 2012. Ideology, motivated reasoning, and cognitive reflection: An experimental study. Judgm. Decis. Mak. 8, 407–24.
Kahan, D.M., Braman, D., Gastil, J., Slovic, P., Mertz, C.K., 2007. Culture and Identity-Protective Cognition: Explaining the White-Male Effect in Risk Perception. J. Empir. Leg. Stud. 4, 465–505. https://doi.org/10.1111/j.1740-1461.2007.00097.x
Kahan, D.M., Peters, E., Dawson, E.C., Slovic, P., 2017. Motivated numeracy and enlightened self-government. Behav. Public Policy 1, 54–86. https://doi.org/10.1017/bpp.2016.2
Kahan, D.M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L.L., Braman, D., Mandel, G., 2012. The polarizing impact of science literacy and numeracy on perceived climate change risks. Nat. Clim. Change 2, 732–735.
Kelley, H.H., 1950. The warm-cold variable in first impressions of persons. J. Pers. 18, 431–439.
Kunda, Z., 1990. The case for motivated reasoning. Psychol. Bull. 108, 480.
Li, L., Switzer, A.D., Wang, Y., Chan, C.-H., Qiu, Q., Weiss, R., 2018. A modest 0.5-m rise in sea level will double the tsunami hazard in Macau. Sci. Adv. 4, eaat1180.
Lipkus, I.M., Samsa, G., Rimer, B.K., 2001. General performance on a numeracy scale among highly educated samples. Med. Decis. Making 21, 37–44.
Lord, C.G., Ross, L., Lepper, M.R., 1979. Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. J. Pers. Soc. Psychol. 37, 2098.
Luchins, A.S., 1942. Mechanization in problem solving: The effect of einstellung. Psychol. Monogr. 54, i.
Mackay, C., 1933. Extraordinary popular delusions and the madness of crowds. L. C. Page & Company, Boston.
MARD, 2020. Environmental and Social impact Assessment Report (ESIA), Project report: Mekong delta integrated climate resilience and sustainable livelihoods (MD- ICRSL/WB9). Ministry of Agriculture and Rural Development, Hanoi.
Miller, J.D., 2004. Public understanding of, and attitudes toward, scientific research: What we know and what we need to know. Public Underst. Sci. 13, 273–294.
Moscovici, S., 1963. Attitudes and Opinions. Annu. Rev. Psychol. 14, 231–260. https://doi.org/10.1146/annurev.ps.14.020163.001311

Nicholls, R.J., Adger, W.N., Hutton, C.W., Hanson, S.E. (Eds.), 2020. Deltas in the Anthropocene. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-030-23517-8
Nicholls, R.J., Cazenave, A., 2010. Sea-Level Rise and Its Impact on Coastal Zones. Science 328, 1517–1520. https://doi.org/10.1126/science.1185782
Nickerson, R.S., 1998. Confirmation bias: A ubiquitous phenomenon in many guises. Rev. Gen. Psychol. 2, 175.
Nyhan, B., 2020. Facts and Myths about Misperceptions. J. Econ. Perspect. 34, 220–236. https://doi.org/10.1257/jep.34.3.220
Nyhan, B., Reifler, J., 2010. When Corrections Fail: The Persistence of Political Misperceptions. Polit. Behav. 32, 303–330. https://doi.org/10.1007/s11109-010-9112-2
Peterson, C.R., DuCharme, W.M., 1967. A primacy effect in subjective probability revision. J. Exp. Psychol. 73, 61.
Pitz, G.F., Downing, L., Reinhold, H., 1967. Sequential effects in the revision of subjective probabilities. Can. J. Psychol. Can. Psychol. 21, 381.
Rabin, M., Schrag, J.L., 1999. First impressions matter: A model of confirmatory bias. Q. J. Econ. 114, 37–82.
Slangen, A.B.A., Carson, M., Katsman, C.A., Van de Wal, R.S.W., Köhl, A., Vermeersen, L.L.A., Stammer, D., 2014. Projecting twenty-first century regional sea-level changes. Clim. Change 124, 317–332.
Storlazzi, C.D., Gingerich, S.B., van Dongeren, A., Cheriton, O.M., Swarzenski, P.W., Quataert, E., Voss, C.I., Field, D.W., Annamalai, H., Piniak, G.A., McCall, R., 2018. Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. Sci. Adv. 4, eaap9741. https://doi.org/10.1126/sciadv.aap9741
Taber, C.S., Lodge, M., 2006. Motivated skepticism in the evaluation of political beliefs. Am. J. Polit. Sci. 50, 755–769.
Verplanken, B., Orbell, S., 2022. Attitudes, habits, and behavior change. Annu. Rev. Psychol.
Vitousek, S., Barnard, P.L., Fletcher, C.H., Frazer, N., Erikson, L., Storlazzi, C.D., 2017. Doubling of coastal flooding frequency within decades due to sea-level rise. Sci. Rep. 7. https://doi.org/10.1038/s41598-017-01362-7
World Medical Association, 2013. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA 310, 2191–2194. https://doi.org/10.1001/jama.2013.281053
Zmigrod, L., Eisenberg, I.W., Bissett, P.G., Robbins, T.W., Poldrack, R.A., 2021. The cognitive and perceptual correlates of ideological attitudes: a data-driven approach. Philos. Trans. R. Soc. B Biol. Sci. 376, 20200424. https://doi.org/10.1098/rstb.2020.0424

3 Why do people persist in sea-level rise threatened coastal regions? Empirical evidence on risk aversion and place attachment*

Ivo Steimanis, Matthias Mayer, Björn Vollan[1†]

Abstract

Climate change is projected to increase the number of extreme weather events, which may lead to cascading impacts, feedbacks, and tipping points not only in the biophysical system but also in the social system. To better understand societal resilience in risky environments, we analyzed people's attachment to place, their willingness to take risks, and how these change in response to extreme weather events. We conducted a survey with 624 respondents at the forefront of climate change in Asia: the river deltas in Bangladesh and Vietnam. Our findings confirm that most people prefer staying. Yet crucially, we find that (i) self-reported experiences of climate-related hazards are associated with increased risk aversion and place attachment, reinforcing people's preferences to stay in hazardous environments; (ii) people with experiences of hazards are more likely aspiring to move to high-income destinations, arguably being beyond the reach of their capacities; and (iii) changes in aspirations to move abroad are connected to the changes in risk aversion and place attachment. The fact that preferences are associated with cumulative experiences of hazards and interact with aspirations to move to high-income destinations may contribute to our understanding of why so many people stay in hazardous environments.

Keywords: Climate hazards, risk aversion, place attachment, international migration aspiration, societal resilience, trapped population

---

* This essay has been published as: Steimanis, I., Mayer, M., Vollan, B., 2021. Why do people persist in sea-level rise threatened coastal regions? Empirical evidence on risk aversion and place attachment. Climate Risk Management 34, 100377. https://doi.org/10.1016/j.crm.2021.100377

[1] Authors affiliation: School of Economics and Business, Universität Marburg, Germany

[†] Correspondence: Björn Vollan, bjoern.vollan@wiwi.uni-marburg.de

Acknowledgments: We are grateful to Abu Siddique and Maximilian N. Burger for research assistance and collecting data in Bangladesh, Dat Nguyen for his assistance in Vietnam, and all participants taking part in this study. We are especially grateful to our local research assistants in both study sites who significantly contributed to the success of the data collection and thereby the whole project.

Funding: Research was funded by the Robert Bosch Foundation (grant number: 32.5.F082.0001.0). Authors declare no competing interests.

Ethics statement: The study design and field implementation were designed and conducted according to the World Medical Association Declaration of Helsinki (2013). All respondents gave their informed consent in written form and were free to resign from the study at any time.

Data and materials availability: The replication package containing the raw data and Stata code can be accessed via GitHub (https://github.com/IvoSteimanis/migration-SLR).

3.1 Introduction

Climate change, particularly sea-level rise (SLR) (Storlazzi et al., 2018; Vitousek et al., 2017), will alter the ecosystems of some of the world's most densely populated and economically active coastal regions in the years to come (Church et al., 2013; Neumann et al., 2015; Nicholls and Cazenave, 2010). People living in these areas will be exposed to more climate-related hazards (Kharin et al., 2018) potentially occurring simultaneously (Zscheischler et al., 2018). Yet, there is a growing consensus among scientists that most people prefer to adapt in-situ (Hauer et al., 2020) and it is predicted that most people will move only within borders (Rigaud et al., 2018). While there is a steadily growing literature on how climate change might erode people's financial ability to move (Black et al., 2013; Groth et al., 2020) there is much less research exploring how people's preferences are affected by increasing exposure to climate-related hazards, and how this, in turn, affects their decisions to move or persist in place (Adams, 2016; Hunter et al., 2015). Taking the example of aspirations to move, our research tries to better understand feedback loops between the natural and social systems and especially how human motivations respond to an increasing number of extreme events.

Two of the main reasons to stay in place at the individual level are people's strong place attachment (Adams, 2016; Esteban et al., 2019; Laurice Jamero et al., 2017) and risk aversion (Beine et al., 2020; Goldbach and Schlüter, 2018; Jaeger et al., 2010). Place attachment refers to the bonds, emotions, and feelings that people attach to their social-physical environment (Twigger-ross and Uzzell, 1996) and risk aversion is the inclination to choose a situation with certain outcomes (e.g., staying) over a situation with more uncertainty yet with higher expected outcomes (e.g., moving to a new place)[1]. While moving abroad can be highly beneficial both for individual wages and societal welfare (Clemens et al., 2019), it is also perceived to be a costly and risky endeavor requiring a certain willingness to take risks (Bryan et al., 2014). The assumption of stable preferences has long been applied to economic models (Stigler and Becker, 1977; West and McKee, 1983) supported by empirical evidence in certain domains (Carlsson et al., 2014; Meier and Sprenger, 2015). Therefore, economic models mainly consider changes in financial and legal constraints to affect outcomes paying less attention to social factors such as peoples' values, perceptions, and preferences (Adger et al., 2009). However, co-evolutionary perspectives highlight that human behaviors are conditioned by human biology, but cultural learning, experimentation, and imitation can change them (Norgaard, 1994). This "diffuse" co-evolutionary perspective not only focuses on genes but also on institutions, technologies, values, and beliefs. Thus, risk preferences and place attachment might change with cumulative experiences of hazards, which contain information about the fragility of the environment they live in.

In this paper, we study if international migration aspirations, place attachment, and risk aversion are associated with climate-related hazards and how these preferences interact with aspirations. Thereby, our study contributes to and tries to combine the literature on how disasters affect fundamental economic preferences and the empirical literature on climate-induced migration. First, studies on the impact of disasters show that risk aversion (Beine et al., 2020; Cameron and Shah, 2015; Cassar et al., 2017; Eckel et al., 2009; Page et al., 2014), time discounting (Bchir and Willinger, 2013; Callen, 2015; Cassar et al., 2017) and social preferences (Becchetti et al., 2017; Cassar et al., 2017; Fleming et al., 2014; Rao et al., 2011; Veszteg et al., 2015; Whitt and Wilson, 2007) can be affected by such events. With regard to risk preferences the evidence suggests that people are temporarily more risk-tolerant directly after experiencing an environmental disaster (Eckel et al., 2009; Page et al., 2014), while in the long run, they seem to become more risk-averse (Beine et al., 2020; Cameron and Shah, 2015; Cassar et al., 2017). Place attachment, on the other hand, is predominantly used as a predictor or mediating variable to explain environmental risk perception, adaptation, and coping behavior (Bonaiuto et al., 2016; De Dominicis et al., 2015; Mishra et al., 2010). Only a few studies examined how place attachment itself might be influenced by the experience of natural disasters (Ruiz and Hernández, 2014; Tanner, 2012; Willox et al., 2012). For example Ruiz and Hernández (2014) find a decrease in place attachment after a volcanic eruption for people living in the area closest to the eruption.

Second, a variety of methodologies have been used to study whether climatic factors lead people to move away, with results ranging from increased migration to people being trapped (Beine and Jeusette, 2019; Berlemann and Steinhardt, 2017; Cattaneo et al., 2019)[2]. A recent trend in the literature is the depiction of migration decisions as the joint outcome of aspiration and ability to move. This conceptual distinction proposed by Carling (2002) has been widely adopted by a broad range of scholars from different disciplines studying migration and conceptually expanded (Haas, 2021, 2010; Schewel, 2020) – (for an overview of the developments, see Carling and Schewel (2018). All these theoretical migration models have one feature in common: aspirations are the precondition for migration which both interact with micro- (individual characteristics) and meso-/macro-level factors such as the emigration environment (norms, social structures, political context, etc.). In a world of increasing migration barriers (costs, legal hurdles) migration desires often remain just that – unfulfilled desires. However, this does not mean that these unfulfilled desires cannot have consequences for the people or communities they live in. We think that making the analytical distinction between aspirations and ability underlying the migration decision is especially important when trying to understand (future) climate-related migration – which can drastically change the migration environment through repeated climate hazards or slow-onsetting changes. Identifying migration patterns based

on past migration might not be very predictive of future climate-related migration (Adger et al., 2021). Furthermore, past migrants differ from non-migrants regarding their education (Drabo and Mbaye, 2015), wealth (Black et al., 2011; Bryan et al., 2014; Cattaneo and Peri, 2016), gender(Gray and Mueller, 2012; Mueller et al., 2014), risk aversion (Jaeger et al., 2010), patience (Goldbach and Schlüter, 2018), uncertainty tolerance (Williams and Baláž, 2012), and social network (Beine and Parsons, 2015; Haug, 2008, p. 200; Manchin and Orazbayev, 2018). If we want to explain differences in international migration between more and less affected people by climate hazards, we would mix both underlying processes of the migration decision (aspirations and ability) when only looking at realized migration outcomes. For example, if more affected people would be more likely to aspire to move abroad than less affected people, yet are less likely to realize their aspirations (e.g., because they formed unrealistic aspirations), then using only observed migration outcomes we would wrongly conclude that climate hazards do not affect migration decisions. Lastly, making the distinction between aspirations and the ability to migrate does not only help understand migration patterns but also informs our understanding of why people stay. Therefore, recent empirical papers have started analyzing data sets on migration intentions (Bertoli et al., 2020; Bertoli and Ruyssen, 2018) and perceived exposure to climatic events (Bekaert et al., 2021; Parsons and Nielsen, 2021; Zander et al., 2019). For example, Bekaert et al. (2021) use the Gallup World Polls data which offers individual-level survey data on migration intentions and self-reported exposure to extreme events for 90 countries in 2010. They find that the probability to intend to migrate rises with exposure to extreme events both within and across borders, especially the relative effects are largest for intentions to move across borders within the same region.

Our study seeks to go beyond the state of the art by combining these two strands of the literature using a unique dataset of affected coastal populations in two countries. We report empirical evidence from surveys conducted with people living in the Ganges Delta in Bangladesh (n = 247) and the Mekong Delta in Vietnam (n = 377). People living at these two densely populated sea-level rise hotspots are continuously exposed to multiple climate-related hazards. Contrary to studies using representative migration aspiration surveys (Bekaert et al., 2021; Bertoli et al., 2020; Migali and Scipioni, 2019) or studies with a focus on urban populations (Zander et al., 2019), we explicitly focus on regions where people depend on livelihood practices (e.g. fishing and farming) that are highly vulnerable to climate change. Based on respondents' recall of flooding, droughts, and storm surges in the past five years, we categorize them into three distinct groups of (i) having experienced no hazards (n = 171, 27%), (ii) one or two hazards (n = 211, 34%) or (iii) three or more hazards (n = 242, 39%). By exploiting information on individuals' affectedness by hazards within each village, we do not measure the impact of hazards at

the village level but at the individual level. This approach has the strength of reducing selection bias as one compares individuals within a community with similar context factors and not between communities that might differ in many dimensions. In addition, what matters for people's behaviors is their risk perception which is shaped by their experiences of past hazards (Grothmann and Patt, 2005; Wachinger et al., 2013). Bekaert et al. (2021) show that their results hold even when controlling for objective measures of extreme events, highlighting how people process climate change and extreme events can explain unique variations in peoples' (intended) decisions to stay or persist (Hunter et al., 2015; Koubi et al., 2016b). Our results should be evaluated and interpreted cautiously for two reasons. First, they are correlations and not causal relationships as, for example, it could be the case that risk aversion affects how people perceive and interpret the same climate hazard. Second, the sample is only representative of sea-level rise affected regions in each country and may not extrapolate to the larger populations in Bangladesh and Vietnam or other coastal regions.

3.2 Materials and methods

3.2.1 Study sites

Global sea levels are expected to rise between 0.54±0.19 meters and 0.71±0.28 meters until the end of the 21st century (Becker et al., 2012; Church et al., 2013). In tropical regions, however, changes can be up to 20 percent higher (Slangen et al., 2014), where a 10 to 20 cm rise in sea levels would already more than double the number of extreme events, such as large waves, storm surges, and coastal flooding (Vitousek et al., 2017).

Bangladesh's flat topography, low-lying coastal plain with 230 rivers and river branches, high population density, and dire socio-economic situation in many regions make it one of the countries most vulnerable to extreme climate events. Our study was conducted in the Barisal division in the Ganges Delta, where people are threatened by tropical storms, typically making landfall at least once per year, cyclone-generated coastal floods, river floods, riverbank erosion, salinization of grounds, and droughts which all are expected to worsen with rising temperatures (Auerbach et al., 2015). Additionally, sea-level rise is expected to increase the severity of coastal flooding during storm surges (Bhuiyan and Dutta, 2012) and tsunamis (Li et al., 2018), as well as accelerate coastal erosion and salinization (Nicholls and Cazenave, 2010; Smajgl et al., 2015). In the five years before our data collection in 2018, the Barisal division was hit by three major cyclones in 2013, 2015, and 2016 as well as two severe floods in 2014 and 2015 (EM-DAT, 2021). According to the latest census data on population in the Barisal division in 2011, the Barisal division had a total population of almost 8.33 million and a growth rate of 1.71%

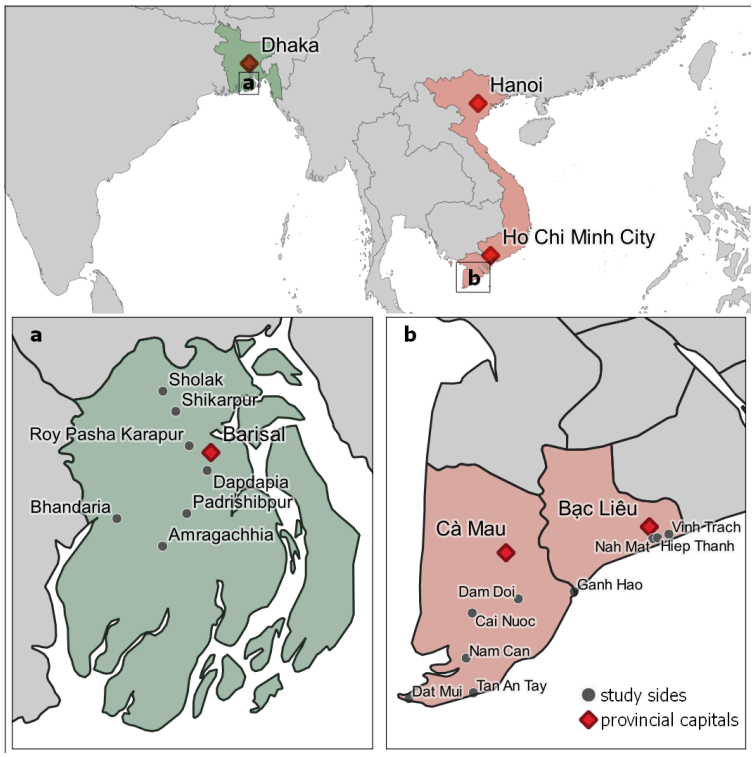
compared to 2001 (BBS, 2015, 2011). Population growth is quite high considering that only 60% of those who were born in the Barisal division still live there; 21% went to Dhaka and 14% to Khulna in pursuit of business opportunities, to find work, better education, or because of marriage (BBS, 2015). Latest predictions using agent-based modeling further suggest that the population might actually increase in Bangladesh's coastal areas despite SLR (Bell et al., 2021). As of yet, environmental hazards did not seem to have resulted in widespread migration. Although it might be difficult to clearly distinguish between environmental and economic reasons to move, studies using mobile phone data found that extreme environmental events are more likely to spark short-term movements instead of permanent migration flows (Lu et al., 2016).

Vietnam, also one of the most vulnerable countries to climate change, was ranked 6th place (three places above Bangladesh) on the Global Climate Risk index in 2019 (Eckstein et al., 2019). Surveys were conducted in Ca Mau and Bac Lieu province in the Mekong Delta, which is highly exposed to sea-level rise due to its extremely flat topography; most of the Delta lies less than 2 meters above the current sea levels. In addition, the Delta itself seems to be sinking. Land subsidence between 0.35 to 1.4 meters on top of SLR of 0.07 to 0.14 meters is expected until 2050 (Erban et al., 2014). Extreme weather events such as droughts, floods, and high-intensity tropical storms are expected to increase (Nicholls et al., 2020). While most typhoons make landfall in Northern or Central Vietnam, they can have devastating consequences if they make landfall in South Vietnam. For example, typhoon Linda left 3,111 people dead, 383,000 people homeless, and caused estimated damage of over $385 million (USD) in 1997 (Anh et al., 2017). Yet, the biggest threat comes from floods during storm surges and high tides that coincide with the monsoon season. Already, water levels can rise by over one meter during this time, causing regular flooding in the region (IMHEN, Ca Mau PPC, 2011). In the five years before our data collection in 2019, the provinces Ca Mau and Bac Lieu suffered from two major floods in 2013 and 2017 (EM-DAT, 2021). Additionally, the Mekong Delta region is susceptible to severe drought events with long-term durations. The most severe drought on record took place between 2015–2016 (Guo et al., 2017). Whenever the flow of fresh water from rainfalls decreases in the dry season, saline intrusion increases in the canals and rivers. Farmers adjust by shifting crops seasonally from rice during the wet season to the considerably more risky shrimp production in the dry season. The total population of Ca Mau and Bac Lieu provinces is 1.2 mission and 0.9 million respectively, with an annual growth rate of 0.12% and 0.66% over the last 10 years (General Statistics Office (GSO), 2020). In 2019, the annual net migration rate for Ca Mau and Bac Lieu were 63 and 52 per 1,000 people respectively. According to the national migration survey, this out-migration is not driven by environmental factors, but rather by young people (85% of all migrants are between 15 and 39) in pursuit of economic possibilities, better education, or family-

related factors (General Statistics Office (GSO), 2016). Recent studies using agent-based modeling to explain migration patterns suggest that employment prospects and potential income accounted for 81% of the reasons people are considering when deciding where to migrate to when leaving the Mekong Delta; education opportunities accounted only for 13% and 5% respectively (Nguyen et al., 2021).

While the Ganges Delta in Bangladesh and the Mekong Delta in Vietnam are quite different in many regards, not just in their institutions, cultures, and socio-economic situation, they nevertheless face a similar exposure to rising sea levels due to the characteristics of major river deltas (Nicholls et al., 2020). Thus, in this study, we interviewed people from two very different contexts, yet who all face the same dilemma: staying in an increasingly hazardous area or moving away.

FIG. 3.1 STUDY SITES



Notes: Own creation using shapefiles from Natural Earth in QGIS.

3.2.2 Sampling

Our study is not a comparative case study, nor is it representative of the entire population of Bangladesh or Vietnam. Instead, we deliberately chose to conduct our study in remote areas that are most affected by SLR and where people are likely among the first to be displaced. We interviewed 247 respondents from 7 communities in the Barisal division, Bangladesh in August 2018, and 377 respondents from 9 communities in Ca Mau and Bac Lieu provinces, Vietnam in April 2019. Respondents were sampled from communities with an average size of about 200 households. While these rural communities mainly

depend on agriculture, aquaculture, and fishing, they vary in their distance to urban centers with populations greater than 100,000, ranging from 7 to 39 km in Bangladesh and 6 to 77 km in Vietnam (see Fig. 3.1.)

In Bangladesh, research was conducted in cooperation with the BRAC Institute of Governance and Development (BIGD), who provided experienced enumerators and data on the affectedness of unions in the Barisal division, guiding our preselection unions from which we randomly selected villages. In Vietnam, sampling was conducted by identifying a list of potential research sites based on their exposure to rising sea levels and randomly selecting eight communities from the list of potential sites. Respondents were randomly selected following a random walk procedure in each community, where enumerators were given a random starting point from which they headed off in different directions choosing either the left or right side of the street, interviewing a person from every third household, and taking a left turn on every second corner. If a household was not available for the interview or rejected to participate, enumerators were instructed to go to the next household following the same procedure. All surveys were translated into the local language (Bengali, Vietnamese) and carried out with the support of tablets by local enumerators whom we trained and supervised throughout the data collection. The interviews consisted of five parts: (i) personal characteristics, (ii) preference measures and scales, (iii) migration experience and aspirations, (iv) climate change perceptions, and (v) income and wealth measures, and social networks. Respondents, aged 18 and older, earned on average $3.6±1 in Bangladesh and $7.3±2.6 in Vietnam for the 40 minutes long survey. Payments were adjusted to the average daily wage of an unskilled laborer in each study site and converted using the purchasing power parity (PPP) conversion factors from the World Bank to adjust for the relative price differences between countries to buy goods and services.

3.2.3 Measurement of preferences, aspirations, and affectedness

Risk preferences: In Bangladesh, we used the well-established staircase method to elicit respondents' risk attitudes which has been conducted with people in 76 countries (Falk et al., 2018, 2016). The staircase method confronts respondents with five consecutive binary choices between a save but lower amount and a risky lottery with a 50% chance of winning nothing or a higher amount[3]. Depending on the previous choice, respondents are then confronted with the next decision in the sequence, offering the same lottery with either a higher or lower sure amount. In this way, one can categorize respondents from risk-averse to risk-loving. One of the five decisions was chosen at random at the end of the survey to be relevant for payout. In Vietnam, we used a different well-established method to measure respondents' risk attitudes, the Gneezy & Potters (1997) investment task. Respondents are endowed with 20.000 VND and can decide how much they want to invest

in a risky lottery (in steps of 1.000 VND) that pays with an equal chance three times the investment or nothing[4]. The amount that was not invested plus the potential earnings from the lottery were paid out at the end of the survey. The enumerators made sure that respondents understood the task before handing over the tablet and letting respondents make their investment decision using a slider on the touchscreen. Enumerators were explicitly trained to give respondents space and not to observe the decision to minimize potential demand effects.

Both methods measure the same underlying construct of how willing people are to take monetary risks in similar ways and in the same specific domain. To better compare the two risk measurement tasks, we standardized both risk measures between zero and one. In the multivariate regressions, we use the standardized values (z-scores that indicate how far an observation is from the sample mean in standard deviations) to be able to compare effect sizes between risk attitudes and place attachment measurements.

Place attachment: Places are more than just providers of natural resources, space for leisure activities, and space for living. People associate memories, emotions, and feelings with the places and the environment they live in. To measure these deeper meanings people have for places, we used a 12-item psychometric scale developed by Williams & Vaske (2003). This scale distinguishes between two dimensions of peoples' attachment to places: identity[5] and dependence[6]. All items were translated into the local language and then back to English to ensure the correctness of the meaning. The values of Cronbach's alpha statistics, a measurement of interitem covariance, for both the place identity ($\alpha_{Bangladesh}$ = .73; $\alpha_{Vietnam}$= .92) and place dependence ($\alpha_{Bangladesh}$ = .62; $\alpha_{Vietnam}$ = .92) dimension indicate strong internal consistency of the scales Thus, the translated items seem to have relatively strong construct validity indicating that they are associated with the underlying concepts of place identity and dependence.

Aspirations to move abroad: While migration aspirations are always hypothetic, it has been shown that such aspirations are not pure wishful thinking and are predictive for both taking preparations (Ruyssen and Salomone, 2018) and actual migration (Tjaden et al., 2019). We opted for eliciting respondents' current aspirations regarding moving to another country without explicitly distinguishing between permanent or temporary movements or the amount of preparation they already took[7]. However, we did ask respondents to name a specific destination they would aspire to move to and state in an open-question the reasons for doing so. Based on respondents' answers, we can identify the following migration aspirations: (i) staying, (ii) low-income destination, (iii) medium-income destination, and (iv) high-income destination. Detailed information on the aspired destinations by study site, as well as the reasons for choosing these destinations and the perceived costs of moving there, are reported in B.4 supplementary materials.

Climate-related hazards & affectedness: We use self-reported variation in experiences of climate-related weather events (droughts, flooding, and storms)[8] to explain changes in risk preferences, place attachment, and international migration aspirations that shape the decision to stay or leave hazardous areas. We measured the experience of such hazards in a clearly defined time frame (five years) and domain (they personally). On average, respondents reported having experienced 2.7 (Median = 2) hazards, where for 26% of respondents the damages of the last hazard they experienced exceed their monthly household income. Recall data of past events can be noisy and prone to measurement error, as people might differ in their ability to remember such events happening or their perception of what constitutes an extreme hazard or not. If the self-reported experiences of hazards are measured with random noise, then estimates are negatively biased towards zero. For simplicity and to reduce the influence of outliers in reported hazards (one respondent reported 40 events in the last five years), we decided to categorize respondents into three distinct groups: (i) not recalling any hazard (n = 171, 27%), (ii) recalling one or two hazards (n = 211, 34%) and (iii) recalling three and more hazards (n = 242, 39%). This categorization captures variation in perceived affectedness and vulnerability to climate-related hazards across groups. Correlations between the categorical variable of hazards and individual perceptions of past and future severity of climate impacts are positive and highly significant. Respondents that reported more hazards in the past five years are also more likely to report that over the past 10 years cyclones ($r = .34$, $p = .00$) and heavy rainfalls ($r = .22$, $p = .00$) have become more frequent, sea-water was penetrating further inland ($r = .19$, $p = .00$), higher sea-levels in general ($r = .11$, $p = .01$) and more intense ($r = .16$, $p = .00$) but less frequent droughts ($r = -.22$, $p = .00$). The correlations are similar for respondents' beliefs whether the same impacts will become even worse in the next five years. They also reported significantly higher damages (costs and effort) to their houses after the last disaster (see supplementary Table B.2). Thus, these correlations suggest that our key variable of interest likely picks up (cumulative) exposure to these impacts that also shape their future impact and risk perceptions. We believe that individual self-reports of climate hazards likely better reflect individual's exposure to hazards than measures derived monitoring systems such as EM-DAT which are only available at higher administrative units. Our main reasoning why this is the case is, that impacts caused by floods, the main reported hazard, can be very localized. Thus, data from EM-DAT cannot reflect an individuals' own nuanced experience of a hazard. For example, within the same village, a flood will affect households in low-lying areas more than those who are living on higher grounds or who invested in protective measures, i.e. building their house on stilts.

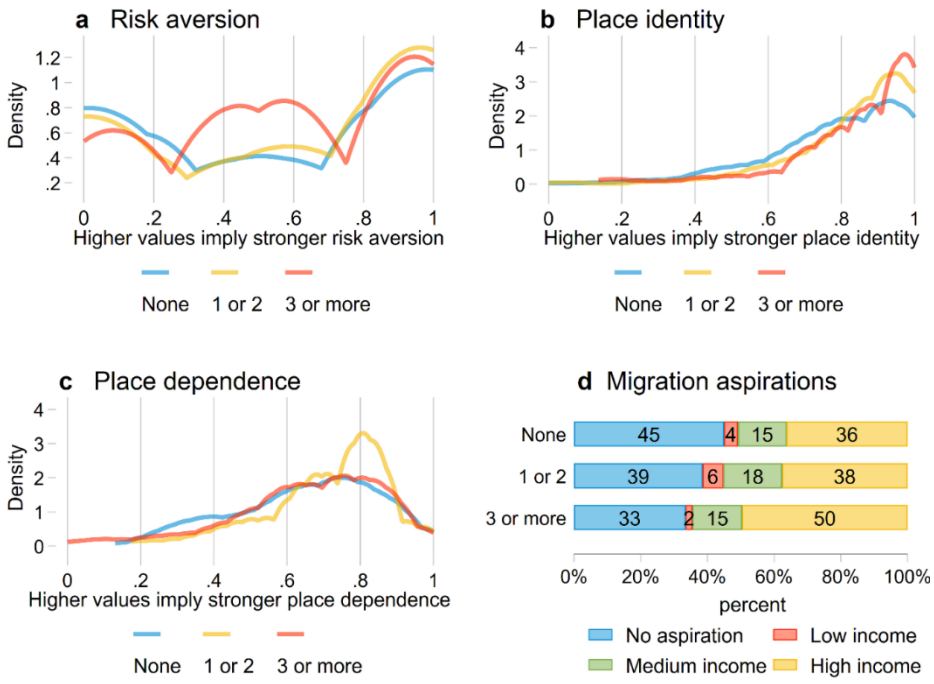
Supplementary Table B.1 provides descriptive statistics of the non-standardized outcome measures and explanatory variables. Over half of our respondents are female (55%), are on average 41 years old, and have completed about seven years of formal schooling. On

average, households consist of about five members that together earn around $754 (median, PPP adjusted) per month. The climate change perception items show that respondents are highly aware of impacts and their consequences, indicating that they already seriously think about how to respond to these hazards.

3.2.4 Preference distributions and migration aspirations

We start with descriptively exploring if the distribution of attitudes towards risk, place identity, and place dependence correlate with the reported experiences of climate-related hazards. Fig. 3.2A-C show the estimated kernel densities of risk preferences, place identity, and place dependence for respondents not recalling any, recalling one or two, and recalling three and more hazards in the last 5 years. On average, respondents tend to be rather risk-averse than risk-loving (Meanrisk = .59±.37), 31% of respondents are even completely risk-averse on our measures. The distribution of risk preferences for the two less exposed groups looks similar with two peaks at the extremes of the distribution. However, having experienced three or more hazards appears to correlate with stronger risk aversion relative to the group that reported none (Kolmogorov-Smirnov (KS) Test D = .17, p = .01), with an additional peak in the middle. Panel b and c showing place identity and place dependence highlight respondents' high levels of attachment (Meanidentity = .85±.17, Meandependence = .69±.18). Respondents who reported experiences of hazards seem to have a stronger place identity, indicated by the significant shift of probability mass to the far right of the distribution for both groups (KS-Test; ‘1 or 2’: D = .13, p = .07; ‘3 or more’: D = .16, p = .02). Regarding the place dependency dimension, we only observe a higher density for the group who reported one or two hazards (KS-Test D = .16, p = .02) but not three and more (KS-Test D = .05, p = .97).

Fig. 3.2 Distribution of preferences and migration aspirations across groups



Notes: We plot the kernel density distributions of risk attitudes (panel A), place identity (panel B), and place dependence (panel C) over the three groups based on the number of self-reported hazards experienced in the past five years. Panel D shows respondents' migration aspirations. Besides, we asked respondents to self-assess all possible costs of moving to the aspired destination, including their costs for living there during the first month. Based on aggregated costs of moving to the aspired destination, we created three distinct groups of destinations: (i) low income (mainly India), (ii) medium income (mainly Middle Eastern countries), and (iii) high-income (i.e., Europe, North America, East Asia). For details on the exact aspired destination, see supplementary materials B.4. While individual estimates of these costs are noisy, aggregating them reveals a realistic picture of migration costs. The average self-assessed migration costs strongly correlate (Pearson-correlation r = .72, p = .00) with legal labor migration costs estimated based on data from the 2009 Bangladesh household remittance survey (IOM, 2010).

The communities and places people live in form important parts of their identities which they highly value and understandably do not want to abandon easily. While people with high place attachment may aspire to form meaningful relationships and strong ties to their local community other people might have different ambitions, desires, and aspirations for their life such as providing a good education for their children, enjoying a higher living standard, or having better economic opportunities (see Table B.19). For rural residents, migration might be the only solution to reach these goals. First, we find that 38% (n = 239) of respondents, state that they either had no desire to move abroad or never actually thought about it (see Fig. 3.2D). The share of respondents reporting no aspiration significantly decreases by 12 percentage points (pp) for respondents who reported three or more hazards (Pearson $Chi^2 = 5.67$, $p = .02$). Thus, cumulative experiences of hazards seem to correlate with the desire to move abroad, especially to high-income destinations in North America, Europe, or East Asia for the most affected respondents (Pearson $Chi^2 = 7.23$, $p = .01$). Of course, as indicated by respondents themselves, it is unlikely that they can realistically act on these aspirations given the substantial financial and legal barriers to migrate to these high-income countries (see Fig. B.5). The aggregated self-

assessed costs of moving to high-income destinations exceed almost three times the respondents' average value of assets.[9]

3.2.5 Statistical analysis

In the following results section, we rely on multivariate least-square regressions for the preference outcomes. For migration aspirations, we use nonlinear functions to model the conditional probability function of the categorical dependent variable.

As one cannot randomly allocate people to be exposed to differing numbers of hazards, people may differ in education or wealth, which can explain variation in the reporting of climate-related hazards. However, previous studies have provided evidence that changes in preferences are more than correlations as they do not stem from selective exposure to disaster or selective out-migration in response to such events, or other changes in the economic environment (Callen, 2015; Cassar et al., 2017). We do not find much evidence for selective exposure, as observed socioeconomic differences do not explain much of the variation in the reported number of hazards (Adj. R^2 = .01, see Table B.4). In addition, 72% of respondents are still living in the same village they were born in, and only 11% of respondents moved in the last 10 years. Thus, there was relatively little in-migration going on in the recalled period. Restricting our analysis to only respondents who were born in the village where we interviewed them, yields similar but less precise estimates due to the exclusion of 28% of respondents from the analysis (see Table B.14). Supplementary Table B.3 shows some slight imbalances between groups in terms of income, where more affected respondents have slightly higher incomes. We control for these imbalances and either include country or village-fixed effects. With the fixed effects we want to remove unobserved heterogeneity between villages in our data. The model with village fixed effects allows for the intercept variable to differ across villages but the slope of the estimate to be constant across all observations. Especially for migration aspirations, we believe that unobserved variables that systematically differ between villages could be correlated with the explanatory variables, and thus, biasing our results. In addition, we account for the issue that the variance of the error term depends on the value of the independent variable using Eicker–Huber–White heteroskedasticity robust standard errors. We estimate variations of the following models for the different outcome variables, for example for the risk aversion model we estimate:

$$Risk\ aversion(z-score)_i = \alpha_1 + \beta_1 Group(1\ or\ 2) + \beta_2 Group(3\ and\ more) + \beta_3 Controls_i + \beta_4 Damages_i + \beta_5 Z_i \varepsilon_{i1}$$

The coefficients $\beta_1\ and\ \beta_2$ capture the effect of the dummy variables of having experienced "one or two" and "three or more" hazards in standard deviations of the outcome variable relative to the omitted group that did not experience any hazard. The

vector of $Controls_i$ includes a set of socio-economics: gender, age, marital status, household size, education, household income, and wealth. We log-transform the reported income and asset values to reduce the influence of extreme outliers on the regression estimates. The vector of $Damages_i$ includes land lost to erosion and an index that captures the costs caused by the last hazard to control for the potential effect on preferences because of reduced wealth. As the self-reported measures of house rebuild frequency, effort, and costs are highly correlated, we use principal component analysis to build a one-dimensional index that captures variation in these variables. Lastly, we control for potential unobserved differences at the village level where the surveys were conducted by including a set of village dummies Z_i.

3.3 Results

In line with previous findings, we find that most respondents (66%, n = 411) would only recommend in-situ adaptations to their peers and view moving away mainly as a last resort if all other adaptation strategies fail (see Fig. B.1). Contrary to the depiction of a population trapped by their financial constraints (Black et al., 2013; Cattaneo and Peri, 2016; Nawrotzki and DeWaard, 2018) most of our respondents could afford moving to domestic urban centers or even to close-by countries assuming they could sell their assets (see Fig. B.5). We start with analyzing if people's preferences and migration aspirations are affected by reported climate hazards.

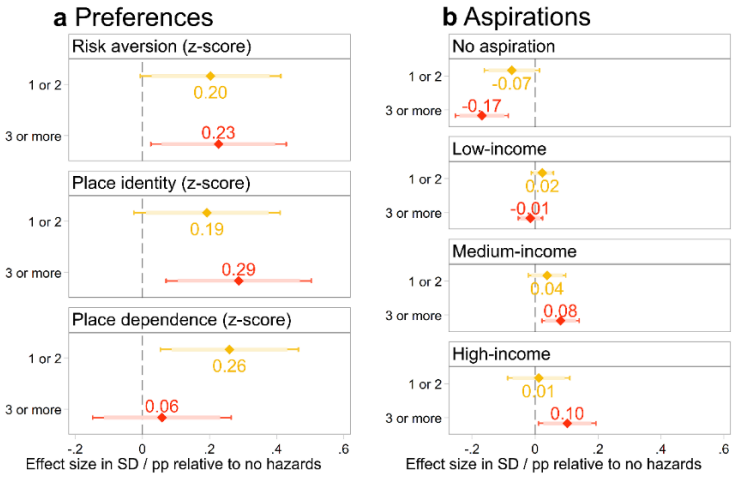
3.3.1 Direct relation between hazards, preferences, and aspirations

Using multivariate regression analysis the descriptive results on distributions are confirmed, showing that preferences are systematically associated with climate-related hazards when controlling for socioeconomic differences across groups and the intensity of damages caused by the most recent hazard (see Fig. 3.3). The interested reader can find the main regression tables reporting all coefficients of the control variables in Supplementary Tables B.5 (preferences) and B.6 (migration aspirations). Respondents who have reported one or two hazards are more risk-averse by 0.2 standard deviations (SD) (β = .20, p = .06, *95CI* = .00, .41) and those who reported three and more by 0.23 SD (β = .23, p = .03, *95CI* = .03, .43) than respondents who reported none. These effects translate roughly into a 12% increase in risk aversion. In comparison, Cassar et al. (2017) find a 20% increase in risk aversion five years after people experienced the extraordinary 2004 tsunami in Thailand. We find similar effects on place identity, which is higher by 0.19 SD for respondents who reported one or two hazards (β = .19, p = .08, *95CI* = -.03, .41) and by 0.29 SD for respondents who reported three and more (β = .29, p = .01, *95CI* = .07, .50). Place dependence, on the other hand, does not seem to correlate in the same way as place

identity with the number of experienced hazards. Respondents who reported one or two hazards tend to have higher place dependence by 0.26 SD (β = .26, p = .01, *95CI* = .05, .47), while respondents who reported three and more hazards have place dependency levels comparable to respondents who reported not having experienced any hazards (β = .06, p = .58, *95CI* = -.15, .27). Fig. 3.3B confirms the descriptive results on aspirations showing that those people who reported three and more hazards are significantly more likely to have formed an aspiration to move abroad, especially to high-income destinations (β = .10, p = .03, *95CI* = .01, .19). Respondents who reported three and more hazards are 17 pp less likely to have no migration aspiration than respondents who reported none (β = -.17, p = .00, *95CI* = -.25, -.08).

To sum up, cumulative experiences of climate-induced hazards not only seem to correlate with higher aspirations to move abroad but also with people's preferences. Respondents who report having experienced climate-induced hazards in the last 5 years tend to be more risk-averse and more attached to their place of living. Past research suggests that both stronger attachment (Adams, 2016) and higher risk aversion (Beine et al., 2020) should make it less likely for people to form aspirations to move abroad. Yet, we find the opposite, most strongly for respondents who report three and more hazards. This group seems to be more likely to aspire to move abroad, especially to high-income destinations, which are likely outside the scope of their capacities. In line with argumentation, we find that respondents with an aspiration to move abroad and who reported to have experienced more climate hazards self-evaluate their likelihood to act on these aspirations in the near future as significantly lower compared to less affected respondents (see supplementary Fig. B.2).

Fig. 3.3 Preferences and aspirations associate with reported hazards



Notes: Plotted are the coefficients for respondents who reported having experienced one or two hazards (yellow) and those who reported having experienced three and more hazards (red) on preferences (panel A) and aspirations (panel B) with 95% (thin lines) and 90% (thick lines) confidence intervals. Control variables include land lost to erosion (=1), house rebuild index (PCA), gender, age, marital status, education, household income (log+1), household wealth (log+1) proxied by owned assets, and household size. In all models, we control for village fixed effects to account for unobserved differences across communities that could affect outcomes.

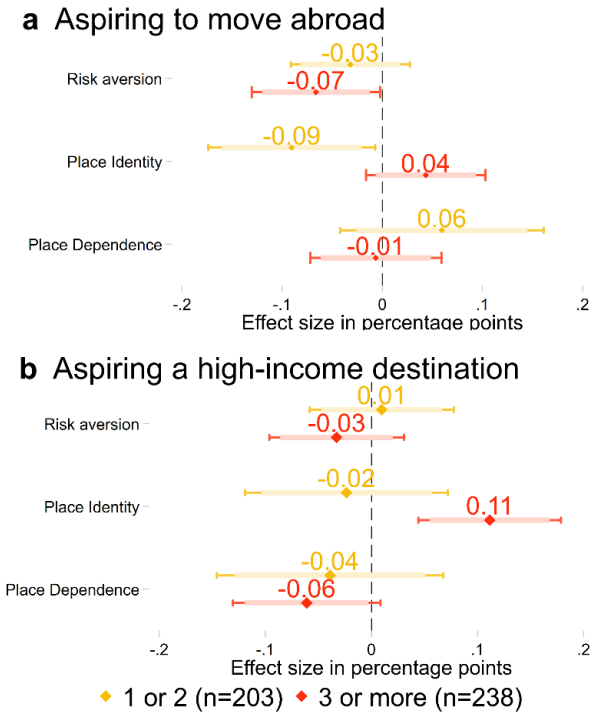
3.3.2 Indirect relation of hazards and migration aspirations through preferences

Next, we explore whether changes in migration aspirations are connected to changes in risk preferences, place identity, and place dependence or whether these effects are independent of each other. We look at two aspiration outcomes: (i) do respondents aspire to move abroad, and (ii) is the aspired destination a high-income country. We estimate average marginal effects for respondents that did not experience any hazards, experienced one or two, or experienced three and more separately using a sample split[10], controlling for factors likely shaping migration aspirations such as age, education, income, and wealth. For brevity, the non-significant effects for respondents that reported no hazards are reported in the supplementary section, not in the main text (see supplementary Table B.15). The results indicate that more educated and wealthier respondents are more likely to aspire to move to high-income destinations, which is in line with studies showing that successful migrants differ significantly from the average population regarding their capacities (better educated (Drabo and Mbaye, 2015), wealthier (Black et al., 2011; Bryan et al., 2014; Cattaneo and Peri, 2016)). For participants reporting three and more hazards, the results further suggest that the desire to move abroad is significantly correlated with risk preferences, after controlling for the above-mentioned factors (Fig. 3.3A). A one SD increase in risk aversion is associated with a 7 pp lower likelihood to aspire to move abroad for this group (β = -.07, p = .04, *95CI* = -.13, -.00). While one might expect that with exposure to more flooding or storm surges uncertainty regarding the current location would rise, the most affected respondents may also perceive the prospect of moving to another country as riskier – rendering international migration as less desirable than adapting in-situ and waiting for a policy solution. Similarly, we find that respondents who identify more strongly with their current location are significantly more likely to aspire to move to high-income destinations, but again only for the group that reported three and more hazards (Fig. 3.3B). Cumulative experiences of hazards alter the relationship between place identity and these aspirations, where a one SD increase in place identity is associated with an 11 pp increase in the likelihood of aspiring to move to a high-income destination (β = .11, p = .00, *95CI* = .04, .18).

To sum up, cumulative experiences of hazards not only affect preferences directly but also the relationship between preferences and international migration aspirations. In addition, we find some heterogeneous effects on migration aspirations depending on how far villages are away from the next urban center with more than 100,000 residents[11]. Respondents from communities further away from urban centers tend to be significantly less likely to aspire to move to medium-income destinations with more experienced hazards compared to respondents living closer to urban centers (see supplementary Table B.18). Thus, respondents from peri-urban communities tend to have more realistic

aspirations to medium-income countries than rural respondents which tend to aspire to move to high-income destinations in our sample.

Fig. 3.4 Effect of hazards through preferences on aspirations



Notes: In panel A, the dependent variable is a dummy variable capturing whether the respondent stated an aspiration to move abroad (=1) or not (=0). The dependent variable in panel B is a dummy variable capturing whether the respondent aspires to move to a high-income destination (=1) or not (=0). Estimation results for respondents who reported having experienced one or two hazards (yellow) and for respondents who reported having experienced three and more hazards (red) are average marginal effects obtained from Probit regressions with 95% (thin lines) and 90% (thick lines) confidence intervals. Additional control variables include land lost to erosion (=1), house rebuild index (PCA), gender, age, education, household income (log+1), household wealth (log+1) proxied by owned assets, and household size. In all models, we control for country-fixed effects. Full regression outputs, including the group that experience no hazards, are reported in supplementary Table B.16.

3.3.3 Study limitations and robustness checks

Our results should be interpreted with caution for several reasons: (i) we measure aspirations to move internationally and not actual movements, (ii) we use self-reported measures of exposure to hazards, and (iii) our sample is not representative of the population of Bangladesh or Vietnam, because we specifically interviewed coastal populations that live in areas most affected by rising sea levels. First, we acknowledge that migration aspirations are not a good proxy for actual migration flows (Abel, 2018). However, there is increasing empirical evidence that the same factors that shape migration aspirations also affect subsequent steps such as migration intentions (Manchin and Orazbayev, 2018; Migali and Scipioni, 2019), preparations (Ruyssen and Salomone, 2018), and actual migration (Creighton, 2013; Docquier et al., 2014; Tjaden et al., 2019). As highlighted by the two-step approaches, actual migration is the joint outcome of aspirations and ability to move, where the latter is clearly lacking among respondents in our sample as most will not have the means to act on their aspirations to move abroad. We

focused on (permanent) international migration aspiration for two reasons: First, most of our respondents have the means to migrate domestically or to neighboring countries but do not do so. Potentially, because they would only migrate if it would mean a substantial improvement to them. Otherwise, they might stay in hazardous environments until they are forced to leave, as highlighted by our conceptual model. Second, the media often speaks about climate migrants, and we wanted to show that those most affected are far from being able to move internationally and that those fears are highly exaggerated and irrational.

Second, self-reported measures of perceived exposure to climate hazards are always prone to recall bias and measurement error. Recall bias might be less of a problem with low-frequency high-impact events than in high-frequency data (Bell et al., 2019). Of more concern is that respondents report different numbers of hazards depending on individual social-psychological factors, which could be consistent with the literature showing that climate risk perceptions are affect by personal experiences of extreme weather events among socio-demographic and cultural factors (Van der Linden, 2015). Then, we would have a measure that captures the combined effect of perception and vulnerability to an exogenous impact. Thus, self-reported experience of climatic events might not match real (or observed) extreme climatic events. However, Hunter et al. (2013) showed that aggregated self-reported measures of drought were strongly associated with objective measures of rainfall in Australia. Similarly, Edwards et al. (2020) using a Filipino sample find that aggregated disaster exposure also correlated well with disaster exposure using EM-DAT data. As we are interested in cumulative and diverse hazards one cannot easily use an all-encompassing source of geo-data that includes floods, typhoons, droughts, landslides, etc. Similarly, we do not have official data on destroyed houses over these hazards, nor can we verify how our individual respondents were affected by these events as EM-DAT data are restricted to division levels. Nevertheless, we believe that self-reported individual exposure is a relevant and valid source of information for our research question. As a robustness check, we generate an individual-specific average exposure to climate hazards based on other participants' reports of hazards in the same community. Our results for risk preferences are robust to using the aggregate measure, while the association with place identity and dependence is not (see supplementary Table B.14). However, this analysis is also less than ideal for two reasons. First, the aggregate measure in this analysis could be imprecise as it assigns respondents who did not report any experiences of hazards in the past five years on average with 2.6 hazards. We believe it is very likely that some individuals remain largely unaffected by some hazards as they might have prepared their belongings better or live at a safer place within the village that is less affected by winds or floods. Second, the interpretation of the model is different as we cannot rule out village-specific characteristics through the inclusion of village fixed effects with the aggregate measure. While individual reports of climate hazards are prone to

outliers and potentially shaped by individual characteristics, the aggregate measure takes away all variation of hazards within villages. We think the grouping of reported hazards offers the best compromise to understand individual responses (risk aversion, place attachment, aspirations) by allowing individual variation in reported hazards within communities while also rigorously constraining outliers to a maximum of "three and more".

Lastly, one might be concerned that people have moved between the occurrence of climate hazards (we used the past five years) and the time when we interviewed them. This would be problematic if a large proportion moved and especially when these people were systematically less risk-averse and attached to their communities. Since we would not have them in our survey, our results might then be driven by a selection bias, only interviewing more risk-averse and place-attached people who remain in these hazardous areas. However, studies show that major out-migration did not happen yet (Adger et al., 2021) and that people rather move temporarily and short distances to urban centers in response to fast-onset disasters like floods and cyclones (Lu et al., 2016), and return as soon as possible (Hauer et al., 2020). At our study sites, the last disaster registered on EM-DAT took place 27 and 20 months before we conducted our surveys, in Bangladesh (cyclone) and Vietnam (flood) respectively. Thus, most people will likely have returned to their villages and are included in our sample. In addition, highlighting that the scope of out-migration cannot be that big, the population of Bangladesh's coastlines is expected to increase (Bell et al., 2021). Those who do migrate seem to be manly young people in pursuit of economic opportunities, better education, or marriages, not environmental concerns (BBS, 2015; General Statistics Office (GSO), 2016; Nguyen et al., 2021). As a result, it seems unlikely that our results are due to talking only to the most attached and risk-averse people.

Additional robustness checks are reported in Supplementary Section B.3. We show that our results are not artifacts of pooling the data from both study sites by showing country-specific models using the non-standardized outcomes (Table B.7 to Table B.9). Our results for Bangladesh are robust to using a binary specification of the risk measure estimated using probit regression models showing that the clustering of observations at the extremes is not driving the results in the pooled analysis (Table B.12, model 3). We use different models to account for censoring of measures at the extremes of our scales of risk attitudes and place attachment (Table B.11), use appropriate models that account for the fact that most of our outcomes variables are not continuous (Table B.12), and use seemingly unrelated regressions (SURE) to account for the correlation between the two dimensions of place attachment (Table B.10). Lastly, we look at heterogeneous effects across hazard groups depending on preferences (Table B.16 and Table B.17) and the distance of communities to the next urban center (Table B.18).

3.4 Discussion and Conclusions

An increasing number of case studies on climate mobility have highlighted that it is important to understand the reasons why people — voluntary or involuntary — stay in hazardous areas (Adams, 2016; Esteban et al., 2019; Laurice Jamero et al., 2017). Changes in fundamental preferences (Becchetti et al., 2017; Beine et al., 2020; Cameron and Shah, 2015; Cassar et al., 2017) and migration intentions (Adger et al., 2021; Bekaert et al., 2021; Bertoli et al., 2020) in response to climate change are increasingly studied, however, to the best of our knowledge no studies combine these two strands of the literature to understand how changing risk preferences and place attachment affect (im-)mobility. One fundamental economic preference is the attitude towards risk which affects many important life decisions. In this study, we find that people who reported exposure to more climate-related hazards tend to be more risk-averse (Fig. 3.3) which looked at in isolation may already be worrying. Poverty has been associated with risk-averse decision-making, perpetuating poverty (see Haushofer & Fehr, 2014 for a review). Risk-averse farmers are less likely to adopt new technologies or diversify their incomes (Alemayehu et al., 2018), potentially further solidifying their state of poverty (Liu and Huang, 2013). Likewise, we find that respondents who are more risk-averse are less likely to aspire to move abroad (Fig. 3.4A). In addition, place identity, a central component for why people persist in hazardous environments (Adams, 2016), seems to be higher for respondents who experienced more climate-related hazards. Again, this result in isolation may already be worrying as it might prolong the time people remain in hazardous environments. Yet, for the most affected respondents in our sample, this increase in place identity seems to be associated with a higher likelihood to have an aspiration to move to a high-income destination (Fig. 3.4B). While aspiring below one's actual potential has been called a potential cause for poverty traps (Appadurai, 2004; Banerjee et al., 2006, pp. 409–421), less is known about the effects of aspiring beyond one's potential. Evidence shows that people with unrealistic life goals in terms of education or income tend to be rather demotivated to work towards their goals and are unlikely to reach them (Genicot and Ray, 2017; Ross, 2019). Given that most respondents could not afford to move to high-income destinations, having these unrealistic aspirations might lead them to neglect closer and more affordable migration destinations.

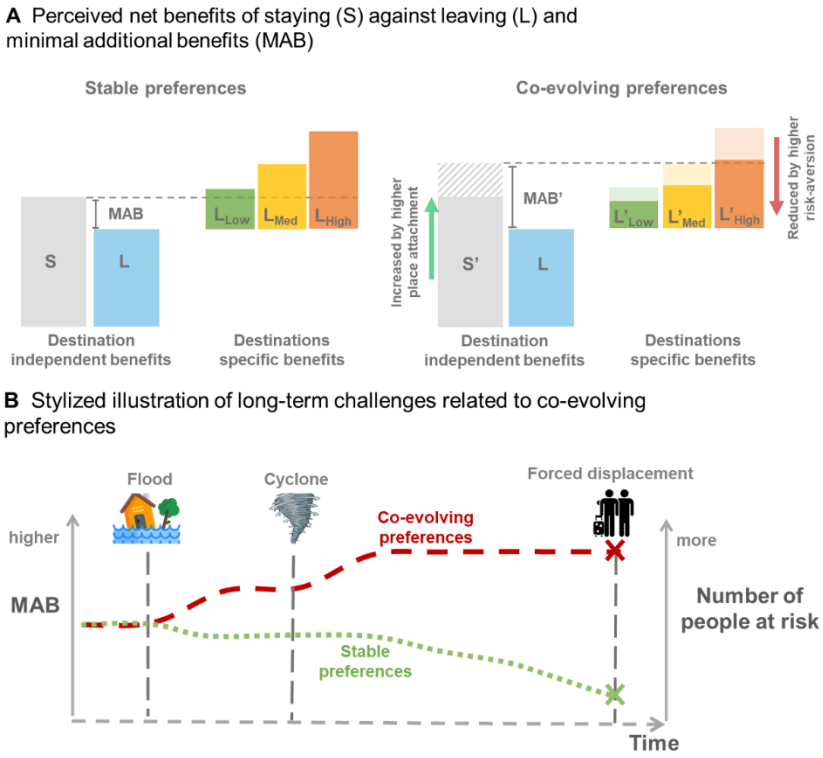
Our results suggest that the experiences of floods or droughts can directly affect people's preferences and aspirations. With increasing experiences of hazards, in our sample of three or more events, preferences start to explain variation in migration aspirations. Higher place identity correlates with the aspirations to move to high-income countries while risk aversion is associated with lower aspirations to move at all. This interplay of preferences and migration aspirations is illustrated schematically in Fig. 3.5 to illustrate potential

pathways of societal resilience to an increasing number of extreme events. In essence, we assume people to form migration aspirations based on their subjective comparison of perceived net benefits from staying against perceived net benefits from leaving (panel A). While staying in a hazardous environment comes at the risk of suffering from climate hazards, people also derive benefits from staying, such as their attachment to place, established social networks, the comfort of the familiar, as well as other intangible values. Thus, the perceived net benefits we refer to include the sum of all costs and benefits relevant to the individual. Leaving a hazardous area comes with the benefit of being less exposed to adverse events as well as benefits derived from living at the new destination, e.g., higher wages or access to better education and healthcare. While moving to a high-income country might be associated with higher benefits overall, the likelihood of success, e.g., being permitted and finding a permanent job, is much lower than in low- or middle-income countries. In our schematic representation, people will only form aspirations to migrate if their perceived net benefits of leaving are higher than their perceived net benefits of staying. We illustrate this in Fig. 3.5A ("stable preferences"), where the destination-specific net benefits of low-, middle-, and high-income would all exceed the minimal additional benefits necessary (MAB) to form an aspiration to move, indicated by the horizontal dashed-line. All illustrated benefits are purely exemplary to illustrate how co-evolving preferences might affect aspirations to move abroad. Stable preferences relate to the theoretical assumption, often made in economics, that preferences are independent of hazard and changes in behavior are only explained by changes in budget constraints.

In Fig. 3.5A ("co-evolving preferences"), we introduce the preference shift we observe in our data, where higher place attachment and risk aversion are associated with accumulative exposure to climate-induced hazards. First, we speculate that stronger place attachment will increase the perceived benefits of staying as the bonds to the place and people are now perceived to be more important. Thus, all else equal, an increase in place attachment would widen the wedge between perceived net benefits of staying and perceived net benefits of leaving in comparison to stable preferences, as indicated by an increase in the minimal additional benefit (MAB'). Consequently, people would be more likely to consider places where the perceived benefits are large enough to exceed the wedge created by the change in preferences. This might explain our finding in Fig. 3.4B that for respondents who report having experienced multiple hazards, place identity is associated with an increase in aspiring to move to a high-income destination. Second, respondents who experienced climate-induced hazards reported a higher risk aversion. In our representation, an increase in risk aversion would lower the perceived benefits of all risky outcomes. Given that moving abroad is perceived to be risky, the destination-specific benefits would decrease (L'_{Low}, L'_{Med}, L'_{High}), and people would be less likely to form

aspirations with potentially only high-income destinations exceeding the required MAB' (see our results in Fig. 3.4A).

Fig. 3.5 Stylized impact of co-evolving preferences on migration aspirations and long-term implications



Notes: Panel A illustrates the interaction of destination independent and dependent benefits of staying and leaving, assuming either stable or co-evolving preferences. Panel B shows the potential long-term implications of co-evolving preferences in terms of the minimal additional benefits that people would require to consider leaving and the total number of people staying in hazardous areas including the resulting risk of forced displacement by gradual climate impacts.

The importance of our study can be seen when extrapolating our findings and the above representation in the future (Fig. 3.5B). Over time, and in line with the latest projections, people will be increasingly exposed to climate-induced hazards. Assuming preferences are stable (green dotted line) only the destination independent benefits (L) of leaving a risky environment would increase. In our representation, this would imply a decrease in the minimal additional benefits (MAB) people require before aspiring to move. However, when people are continuously exposed to natural disasters and preferences are not stable but co-evolve, indicated by the red dashed line, risk-aversion and place attachment could increase with experiencing floods or storm surges and thus further increase the MAB required for leaving. Potentially, this might result in a high number of people being at risk of displacement.

Thus, co-evolving preferences might prolong the time people remain in hazardous places where they are increasingly exposed to immediate impacts by climate-related hazards and gradual impacts, accelerating the risk for socioeconomically marginalized households to eventually lose their ability to move abroad. Those who do not form aspirations to move

abroad might still have to adapt by carrying out small movements to other risky, low-productive close-by locations once the place they live at becomes uninhabitable. There is now a strong need for developing anticipatory governance regimes to identify affected communities at risk of (further) falling into poverty and being exposed to an increasing number of climate-related hazards. As feelings of identification with the community are central to the decision to stay or leave, any resettlement plan should be designed as a participatory process. As people might reject relocation unless the perceived destination-specific benefits are sufficiently large, it is important to offer decent housing, good job opportunities, and public services at the new destination, as well as emphasizing the benefits of leaving the hazardous environment to enhance participation.

3.5 Endnotes

[1] While different people perceive different aspects of life as risky, one might think that staying in a climate change hotspot being exposed to natural disasters is the riskier choice compared to moving to an urban area. However, this view neglects that the risk of moving is more immediate and comes with additional unpleasant uncertainty, including the loss of one's social networks, the lack of decent housing, potential unemployment, adjusting to urban life and different cultures, including the fear of failing.

[2] Studies vary in terms of data sources used to quantify migration (past flows or stocks vs. intentions using individual sample surveys), explanatory climatic variable (objective measures vs. self-reported perceived measures), samples (countries and time period), and the type of migration (internal, international). The field can be broadly categorized in macro and micro-level studies. First, the macro-level economic studies link migration flows and stocks between countries with long-term changes in temperatures and rainfall patterns (e.g. Beine and Parsons, 2015; Cai et al., 2016; Cattaneo and Peri, 2016). Thus, they have to aggregate the data on a coarse spatial area and focus on specific time periods. The problem here is that one cannot know whether the people who moved away were actually affected by the climatic event under investigation. Second, micro-level studies overcome this short-coming by focussing on the migration response to a specific shock such as heat (Mueller et al., 2014) or floods, cyclones and droughts (Bohra-Mishra et al., 2014; Gray and Mueller, 2012; Koubi et al., 2016b, 2016a) in a specific country or region.

[3] The exact wording was as follows: "Please imagine the following situation: You can choose between a sure payment OR a lottery. The lottery gives you a 50 percent chance of receiving 240 Taka, with an equally high chance of receiving nothing. Now imagine you had to choose between the lottery and a sure payment. We will present to you five different situations. The lottery is the same in all situations. The sure payment is different in every situation. At the end of the survey, we would like to thank you for participating and give you a small compensation for your time. One of the following decisions will be chosen at random to determine your payout".

[4] The exact wording was as follows: "You get 20,000 Dong from us at the end of the survey. Your task now is to decide how many Dong you want to keep and how much you would like to invest into a lottery. The lottery pays with 50 percent chance three times the amount you invested and with 50 percent chance your investment is lost. At the end of the survey, we pay you the earnings from this task."

[5] "I feel that this place is a part of me."; "This place is very special to me."; "I identify strongly with this place."; "I am very attached to this place."; "Being at this place says a lot about who I am."; "This place means a lot to me."

[6] "This place is the best place for what I like to do."; "No other place can compare to this place."; "I get more satisfaction out of being at this place than at any other."; "Doing what I do at this place is more important to me than doing it in any other place."; "I wouldn't substitute any other area for doing the types of things I do at this place."; "The things I do at this place I would enjoy doing just as much at a similar site."

[7] The exact wording was as follows: "If you could migrate abroad, where (country) would you go and why (reasons)?")

[8] Respondents were asked: „How many extreme weather events, such as floods, storms or droughts have you experienced in the last 5 years?"

[9] A conservative estimate, assuming that respondents could sell all their movable and immovable for their self-assessed value.

[10] As a robustness check, we use pooled linear probability models where we interact the hazard measure with each preference in a stepwise fashion (see Supplementary Table B.17). The results for risk aversion are similar to the results from the sample split analysis. The significant joint F-tests of the interactions show that the effects of exposure to hazards on having any migration aspiration are modified by risk aversion and place attachment. Risk aversion still dampens the effect of having experienced more than three hazards on

the aspiration to move abroad (and a high-income destination). Regarding the interaction effect of place identity, we only find that place identity is associated with aspirations to move to a high-income country, but this is not significantly amplified with more frequent exposure to climate hazards.

[11] We thank the anonymous reviewer for the suggestion to investigate heterogeneous effects on migration aspirations depending on whether respondents live in more urban or rural areas.

3.6 References

Abel, G.J., 2018. Estimates of Global Bilateral Migration Flows by Gender between 1960 and 20151. Int. Migr. Rev. 52, 809–852. https://doi.org/10.1111/imre.12327

Adams, H., 2016. Why populations persist: mobility, place attachment and climate change. Popul. Environ. 37, 429–448. https://doi.org/10.1007/s11111-015-0246-3

Adger, W.N., Campos, R.S. de, Codjoe, S.N.A., Siddiqui, T., Hazra, S., Das, S., Adams, H., Gavonel, M.F., Mortreux, C., Abu, M., 2021. Perceived environmental risks and insecurity reduce future migration intentions in hazardous migration source areas. One Earth 4, 146–157. https://doi.org/10.1016/j.oneear.2020.12.009

Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D.R., Naess, L.O., Wolf, J., Wreford, A., 2009. Are there social limits to adaptation to climate change? Clim. Change 93, 335–354. https://doi.org/10.1007/s10584-008-9520-z

Alemayehu, M., Beuving, J., Ruben, R., 2018. Risk Preferences and Farmers' Livelihood Strategies: A Case Study from Eastern Ethiopia. J. Int. Dev. 30, 1369–1391. https://doi.org/10.1002/jid.3341

Anh, L.T., Takagi, H., Thao, N.D., Esteban, M., 2017. Investigation of Awareness of Typhoon and Storm Surge in the Mekong Delta – Recollection of 1997 Typhoon Linda. J. Jpn. Soc. Civ. Eng. Ser B3 Ocean Eng. 73, I_168-I_173. https://doi.org/10.2208/jscejoe.73.I_168

Appadurai, A., 2004. The Capacity to Aspire: Culture and the Terms of Recognition. Cult. Public Action.

Auerbach, L.W., Goodbred Jr, S.L., Mondal, D.R., Wilson, C.A., Ahmed, K.R., Roy, K., Steckler, M.S., Small, C., Gilligan, J.M., Ackerly, B.A., 2015. Flood risk of natural and embanked landscapes on the Ganges–Brahmaputra tidal delta plain. Nat. Clim. Change 5, 153–157. https://doi.org/10.1038/nclimate2472

Banerjee, A.V., Benabou, R., Mookherjee, D., 2006. Understanding Poverty. Oxford University Press.

BBS, 2015. Population Distribution and Internal Migration in Bangaldesh. Bangladesh Bureau of Statistics (BBS).

BBS, 2011. Census Reports 2011. Bangladesh Bureau of Statistics (BBS).

Bchir, M.A., Willinger, M., 2013. Does the exposure to natural hazards affect risk and time preferences? Some insights from a field experiment in Perú (Working Paper). LAMETA, Universtiy of Montpellier.

Becchetti, L., Castriota, S., Conzo, P., 2017. Disaster, Aid, and Preferences: The Long-run Impact of the Tsunami on Giving in Sri Lanka. World Dev. 94, 157–173. https://doi.org/10.1016/j.worlddev.2016.12.014

Becker, M., Meyssignac, B., Letetrel, C., Llovel, W., Cazenave, A., Delcroix, T., 2012. Sea level variations at tropical Pacific islands since 1950. Glob. Planet. Change 80–81, 85–98. https://doi.org/10.1016/j.gloplacha.2011.09.004

Beine, M., Charness, G., Dupuy, A., Joxhe, M., 2020. Shaking Things Up: On the Stability of Risk and Time Preferences (SSRN Scholarly Paper No. ID 3570289). Social Science Research Network, Rochester, NY.

Beine, M., Jeusette, L., 2019. A Meta-Analysis of the Literature on Climate Change and Migration (DEM Discussion Paper Series). Department of Economics at the University of Luxembourg.

Beine, M., Parsons, C., 2015. Climatic Factors as Determinants of International Migration. Scand. J. Econ. 117, 723–767. https://doi.org/10.1111/sjoe.12098

Bekaert, E., Ruyssen, I., Salomone, S., 2021. Domestic and international migration intentions in response to environmental stress: A global cross-country analysis. J. Demogr. Econ. 87, 383–436. https://doi.org/10.1017/dem.2020.28

Bell, A., Ward, P., Tamal, Md.E.H., Killilea, M., 2019. Assessing recall bias and measurement error in high-frequency social data collection for human-environment research. Popul. Environ. 40, 325–345. https://doi.org/10.1007/s11111-019-0314-1

Bell, A.R., Wrathall, D.J., Mueller, V., Chen, J., Oppenheimer, M., Hauer, M., Adams, H.J., Kulp, S., Clark, P., Fussell, E., Magliocca, N., Xiao, T., Gilmore, E., Abel, K., Call, M., Slangen, A.B.A., 2021. Migration towards Bangladesh coastlines projected to increase with sea-level rise through 2100. Environ. Res. Lett. https://doi.org/10.1088/1748-9326/abdc5b

Berlemann, M., Steinhardt, M.F., 2017. Climate Change, Natural Disasters, and Migration—a Survey of the Empirical Evidence. CESifo Econ. Stud. 63, 353–385. https://doi.org/10.1093/cesifo/ifx019

Bertoli, S., Docquier, F., Rapoport, H., Ruyssen, I., 2020. Weather Shocks and Migration Intentions in Western Africa: Insights from a Multilevel Analysis (Working Paper No. 8064). CESifo Working Paper.

Bertoli, S., Ruyssen, I., 2018. Networks and migrants' intended destination. J. Econ. Geogr. 18, 705–728. https://doi.org/10.1093/jeg/lby012

Bhuiyan, Md.J.A.N., Dutta, D., 2012. Analysis of flood vulnerability and assessment of the impacts in coastal zones of Bangladesh due to potential sea-level rise. Nat. Hazards 61, 729–743. https://doi.org/10.1007/s11069-011-0059-3

Black, R., Adger, W.N., Arnell, N.W., Dercon, S., Geddes, A., Thomas, D., 2011. The effect of environmental change on human migration. Glob. Environ. Change, Migration and Global Environmental Change – Review of Drivers of Migration 21, S3–S11. https://doi.org/10.1016/j.gloenvcha.2011.10.001

Black, R., Arnell, N.W., Adger, W.N., Thomas, D., Geddes, A., 2013. Migration, immobility and displacement outcomes following extreme events. Environ. Sci. Policy, Global environmental change, extreme environmental events and "environmental migration": exploring the connections 27, S32–S43. https://doi.org/10.1016/j.envsci.2012.09.001

Bohra-Mishra, P., Oppenheimer, M., Hsiang, S.M., 2014. Nonlinear permanent migration response to climatic variations but minimal response to disasters. Proc. Natl. Acad. Sci. 111, 9780–9785. https://doi.org/10.1073/pnas.1317166111

Bonaiuto, M., Alves, S., De Dominicis, S., Petruccelli, I., 2016. Place attachment and natural hazard risk: Research review and agenda. J. Environ. Psychol. 48, 33–53. https://doi.org/10.1016/j.jenvp.2016.07.007

Bryan, G., Chowdhury, S., Mobarak, A.M., 2014. Underinvestment in a Profitable Technology: The Case of Seasonal Migration in Bangladesh. Econometrica 82, 1671–1748. https://doi.org/10.3982/ECTA10489

Cai, R., Feng, S., Oppenheimer, M., Pytlikova, M., 2016. Climate variability and international migration: The importance of the agricultural linkage. J. Environ. Econ. Manag. 79, 135–151. https://doi.org/10.1016/j.jeem.2016.06.005

Callen, M., 2015. Catastrophes and time preference: Evidence from the Indian Ocean Earthquake. J. Econ. Behav. Organ., Economic Experiments in Developing Countries 118, 199–214. https://doi.org/10.1016/j.jebo.2015.02.019

Cameron, L.A., Shah, M., 2015. Risk-taking behavior in the wake of natural disasters. J. Hum. Resour. JHR, Journal of human resources : JHR. - Madison, Wis : University of Wisconsin Press, ISSN 0022-166X, ZDB-ID 2191921. - Bd. 50.2015, 2, S. 484-515 50.

Carling, J., 2002. Migration in the age of involuntary immobility: Theoretical reflections and Cape Verdean experiences. J. Ethn. Migr. Stud. 28, 5–42. https://doi.org/10.1080/13691830120103912

Carling, J., Schewel, K., 2018. Revisiting aspiration and ability in international migration. J. Ethn. Migr. Stud. 44, 945–963. https://doi.org/10.1080/1369183X.2017.1384146

Carlsson, F., Johansson-Stenman, O., Nam, P.K., 2014. Social preferences are stable over long periods of time. J. Public Econ. 117, 104–114. https://doi.org/10.1016/j.jpubeco.2014.05.009

Cassar, A., Healy, A., von Kessler, C., 2017. Trust, Risk, and Time Preferences After a Natural Disaster: Experimental Evidence from Thailand. World Dev. 94, 90–105. https://doi.org/10.1016/j.worlddev.2016.12.042

Cattaneo, C., Beine, M., Fröhlich, C.J., Kniveton, D., Martinez-Zarzoso, I., Mastrorillo, M., Millock, K., Piguet, E., Schraven, B., 2019. Human Migration in the Era of Climate Change. Rev. Environ. Econ. Policy 13, 189–206. https://doi.org/10.1093/reep/rez008

Cattaneo, C., Peri, G., 2016. The migration response to increasing temperatures. J. Dev. Econ. 122, 127–146. https://doi.org/10.1016/j.jdeveco.2016.05.004

Church, J.A., Clark, P.U., Cazenave, A., Gregory, J.M., Jevrejeva, S., Levermann, A., Merrifield, M.A., Milne, G.A., Nerem, R.S., Nunn, P.D., Payne, A.J., Pfeffer, W.T., Stammer, D., Unnikrishnan, A.S., 2013. Sea-Level Rise by 2100. Science 342, 1445–1445. https://doi.org/10.1126/science.342.6165.1445-a

Clemens, M.A., Montenegro, C.E., Pritchett, L., 2019. The Place Premium: Bounding the Price Equivalent of Migration Barriers. Rev. Econ. Stat. 101, 201–213.

Creighton, M.J., 2013. The role of aspirations in domestic and international migration. Soc. Sci. J. 50, 79–88. https://doi.org/10.1016/j.soscij.2012.07.006

De Dominicis, S., Fornara, F., Ganucci Cancellieri, U., Twigger-Ross, C., Bonaiuto, M., 2015. We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. J. Environ. Psychol. 43, 66–78. https://doi.org/10.1016/j.jenvp.2015.05.010

Docquier, F., Peri, G., Ruyssen, I., 2014. The Cross-country Determinants of Potential and Actual Migration. Int. Migr. Rev. 48, 37–99. https://doi.org/10.1111/imre.12137

Drabo, A., Mbaye, L.M., 2015. Natural disasters, migration and education: an empirical analysis in developing countries. Environ. Dev. Econ. 20, 767–796. https://doi.org/10.1017/S1355770X14000606

Eckel, C.C., El-Gamal, M.A., Wilson, R.K., 2009. Risk loving after the storm: A Bayesian-Network study of Hurricane Katrina evacuees. J. Econ. Behav. Organ., Individual Decision-Making, Bayesian Estimation and Market Design: A Festschrift in honor of David Grether 69, 110–124. https://doi.org/10.1016/j.jebo.2007.08.012

Eckstein, D., Hutfils, M.-L., Winges, M., 2019. Global Climate Risk Index 2019: Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2017 and 1998 to 2017 (No. 14). Germanwatch e.V., Bonn.

Edwards, B., Gray, M., Borja, J.B., 2020. The Impact of Natural Disasters on Violence, Mental Health, Food Insecurity, and Stunting in the Philippines: Findings from the Longitudinal Cohort Study on the Filipino Child (SSRN Scholarly Paper No. ID 3520059). Social Science Research Network, Rochester, NY. https://doi.org/10.2139/ssrn.3520059

EM-DAT, 2021. The CRED/OFDA International Disaster Database.
Erban, L.E., Gorelick, S.M., Zebker, H.A., 2014. Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Vietnam. Environ. Res. Lett. 9, 084010. https://doi.org/10.1088/1748-9326/9/8/084010
Esteban, M., Jamero, Ma.L., Nurse, L., Yamamoto, L., Takagi, H., Thao, N.D., Mikami, T., Kench, P., Onuki, M., Nellas, A., Crichton, R., Valenzuela, V.P., Chadwick, C., Avelino, J.E., Tan, N., Shibayama, T., 2019. Adaptation to sea level rise on low coral islands: Lessons from recent events. Ocean Coast. Manag. 168, 35–40. https://doi.org/10.1016/j.ocecoaman.2018.10.031
Falk, A., Becker, A., Dohmen, T., Enke, B., Huffman, D., Sunde, U., 2018. Global Evidence on Economic Preferences. Q. J. Econ. 133, 1645–1692. https://doi.org/10.1093/qje/qjy013
Falk, A., Becker, A., Dohmen, T., Huffman, D., Sunde, U., 2016. The Preference Survey Module: A Validated Instrument for Measuring Risk, Time, and Social Preferences (Working Paper No. 2016–003). Human Capital and Economic Opportunity Working Group.
Fleming, D.A., Chong, A., Bejarano, H.D., 2014. Trust and Reciprocity in the Aftermath of Natural Disasters. J. Dev. Stud. 50, 1482–1493. https://doi.org/10.1080/00220388.2014.936395
General Statistics Office (GSO), 2020. Complete Results of the 2019 Viet Nam Population and Houshing Census. Statistical Publishing House. 2020, Vietnam.
General Statistics Office (GSO), 2016. The 2015 national internal migration survey: major findings. Vietnam News Agency Publishing House, Vietnam.
Genicot, G., Ray, D., 2017. Aspirations and Inequality. Econometrica 85, 489–519. https://doi.org/10.3982/ECTA13865
Gneezy, U., Potters, J., 1997. An Experiment on Risk Taking and Evaluation Periods. Q. J. Econ. 112, 631–645. https://doi.org/10.1162/003355397555217
Goldbach, C., Schlüter, A., 2018. Risk aversion, time preferences, and out-migration. Experimental evidence from Ghana and Indonesia. J. Econ. Behav. Organ. 150, 132–148. https://doi.org/10.1016/j.jebo.2018.04.013
Gray, C.L., Mueller, V., 2012. Natural disasters and population mobility in Bangladesh. Proc. Natl. Acad. Sci. 109, 6000–6005. https://doi.org/10.1073/pnas.1115944109
Groth, J., Ide, T., Sakdapolrak, P., Kassa, E., Hermans, K., 2020. Deciphering interwoven drivers of environment-related migration – A multisite case study from the Ethiopian highlands. Glob. Environ. Change 63, 102094. https://doi.org/10.1016/j.gloenvcha.2020.102094
Grothmann, T., Patt, A., 2005. Adaptive capacity and human cognition: The process of individual adaptation to climate change. Glob. Environ. Change 15, 199–213. https://doi.org/10.1016/j.gloenvcha.2005.01.002
Guo, H., Bao, A., Liu, T., Ndayisaba, F., He, D., Kurban, A., De Maeyer, P., 2017. Meteorological Drought Analysis in the Lower Mekong Basin Using Satellite-Based Long-Term CHIRPS Product. Sustainability 9, 901. https://doi.org/10.3390/su9060901
Haas, H. de, 2021. A theory of migration: the aspirations-capabilities framework. Comp. Migr. Stud. 9, 8. https://doi.org/10.1186/s40878-020-00210-4
Haas, H. de, 2010. The Internal Dynamics of Migration Processes: A Theoretical Inquiry. J. Ethn. Migr. Stud. 36, 1587–1617. https://doi.org/10.1080/1369183X.2010.489361
Hauer, M.E., Fussell, E., Mueller, V., Burkett, M., Call, M., Abel, K., McLeman, R., Wrathall, D., 2020. Sea-level rise and human migration. Nat. Rev. Earth Environ. 1, 28–39. https://doi.org/10.1038/s43017-019-0002-9
Haug, D.S., 2008. Migration Networks and Migration Decision-Making. J. Ethn. Migr. Stud. 34, 585–605. https://doi.org/10.1080/13691830801961605
Haushofer, J., Fehr, E., 2014. On the psychology of poverty. Science 344, 862–867. https://doi.org/10.1126/science.1232491
Hunter, B., Gray, M., Edwards, B., 2013. The Use of Social Surveys to Measure Drought and the Impact of Drought. Soc. Indic. Res. 113, 419–432. https://doi.org/10.1007/s11205-012-0102-0
Hunter, L.M., Luna, J.K., Norton, R.M., 2015. Environmental Dimensions of Migration. Annu. Rev. Sociol. 41, 377–397. https://doi.org/10.1146/annurev-soc-073014-112223
IMHEN, Ca Mau PPC, 2011. Climate Change Impact and Adaptation Study in the Mekong Delta Ca Mau Atlas. Institute of Meteorology, Hydrology and Environment (IMHEN), Ha Noi, Vietnam.
IOM, 2010. The Bangladesh Household Remittance Survey 2009 (Summary Report). International Organization on Migration (IOM), Bangladesh, Dhaka.
Jaeger, D.A., Dohmen, T., Falk, A., Huffman, D., Sunde, U., Bonin, H., 2010. Direct Evidence on Risk Attitudes and Migration. Rev. Econ. Stat. 92, 684–689. https://doi.org/10.1162/REST_a_00020
Kharin, V.V., Flato, G.M., Zhang, X., Gillett, N.P., Zwiers, F., Anderson, K.J., 2018. Risks from Climate Extremes Change Differently from 1.5°C to 2.0°C Depending on Rarity. Earths Future 6, 704–715. https://doi.org/10.1002/2018EF000813
Koubi, V., Spilker, G., Schaffer, L., Bernauer, T., 2016a. Environmental Stressors and Migration: Evidence from Vietnam. World Dev. 79, 197–210. https://doi.org/10.1016/j.worlddev.2015.11.016
Koubi, V., Stoll, S., Spilker, G., 2016b. Perceptions of environmental change and migration decisions. Clim. Change 138, 439–451. https://doi.org/10.1007/s10584-016-1767-1
Laurice Jamero, Ma., Onuki, M., Esteban, M., Billones-Sensano, X.K., Tan, N., Nellas, A., Takagi, H., Thao, N.D., Valenzuela, V.P., 2017. Small-island communities in the Philippines prefer local measures to relocation in response to sea-level rise. Nat. Clim. Change 7, 581–586. https://doi.org/10.1038/nclimate3344

Li, L., Switzer, A.D., Wang, Y., Chan, C.-H., Qiu, Q., Weiss, R., 2018. A modest 0.5-m rise in sea level will double the tsunami hazard in Macau. Sci. Adv. 4, eaat1180. https://doi.org/10.1126/sciadv.aat1180
Liu, E.M., Huang, J., 2013. Risk preferences and pesticide use by cotton farmers in China. J. Dev. Econ. 103, 202–215. https://doi.org/10.1016/j.jdeveco.2012.12.005
Lu, X., Wrathall, D.J., Sundsøy, P.R., Nadiruzzaman, Md., Wetter, E., Iqbal, A., Qureshi, T., Tatem, A., Canright, G., Engø-Monsen, K., Bengtsson, L., 2016. Unveiling hidden migration and mobility patterns in climate stressed regions: A longitudinal study of six million anonymous mobile phone users in Bangladesh. Glob. Environ. Change 38, 1–7. https://doi.org/10.1016/j.gloenvcha.2016.02.002
Manchin, M., Orazbayev, S., 2018. Social networks and the intention to migrate. World Dev. 109, 360–374. https://doi.org/10.1016/j.worlddev.2018.05.011
Meier, S., Sprenger, C.D., 2015. Temporal stability of time preferences. Rev. Econ. Stat. 97, 273–286.
Migali, S., Scipioni, M., 2019. Who's About to Leave? A Global Survey of Aspirations and Intentions to Migrate. Int. Migr. 57, 181–200. https://doi.org/10.1111/imig.12617
Mishra, S., Mazumdar, S., Suar, D., 2010. Place attachment and flood preparedness. J. Environ. Psychol. 30, 187–197. https://doi.org/10.1016/j.jenvp.2009.11.005
Mueller, V., Gray, C., Kosec, K., 2014. Heat stress increases long-term human migration in rural Pakistan. Nat. Clim. Change 4, 182–185. https://doi.org/10.1038/nclimate2103
Nawrotzki, R.J., DeWaard, J., 2018. Putting trapped populations into place: climate change and inter-district migration flows in Zambia. Reg. Environ. Change 18, 533–546. https://doi.org/10.1007/s10113-017-1224-3
Neumann, B., Vafeidis, A.T., Zimmermann, J., Nicholls, R.J., 2015. Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment. PLOS ONE 10, e0118571. https://doi.org/10.1371/journal.pone.0118571
Nguyen, H.K., Chiong, R., Chica, M., Middleton, R.H., 2021. Understanding the dynamics of inter-provincial migration in the Mekong Delta, Vietnam: an agent-based modeling study. SIMULATION 97, 267–285. https://doi.org/10.1177/0037549720975128
Nicholls, R.J., Adger, W.N., Hutton, C.W., Hanson, S.E. (Eds.), 2020. Deltas in the Anthropocene. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-030-23517-8
Nicholls, R.J., Cazenave, A., 2010. Sea-Level Rise and Its Impact on Coastal Zones. Science 328, 1517–1520. https://doi.org/10.1126/science.1185782
Norgaard, R.B., 1994. Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future. Routledge.
Page, L., Savage, D.A., Torgler, B., 2014. Variation in risk seeking behaviour following large losses: A natural experiment. Eur. Econ. Rev. 71, 121–131. https://doi.org/10.1016/j.euroecorev.2014.04.009
Parsons, L., Nielsen, J.Ø., 2021. The Subjective Climate Migrant: Climate Perceptions, Their Determinants, and Relationship to Migration in Cambodia. Ann. Am. Assoc. Geogr. 111, 971–988. https://doi.org/10.1080/24694452.2020.1807899
Rao, L.-L., Han, R., Ren, X.-P., Bai, X.-W., Zheng, R., Liu, H., Wang, Z.-J., Li, J.-Z., Zhang, K., Li, S., 2011. Disadvantage and prosocial behavior: the effects of the Wenchuan earthquake. Evol. Hum. Behav. 32, 63–69. https://doi.org/10.1016/j.evolhumbehav.2010.07.002
Rigaud, K.K., Sherbinin, A. de, Jones, B.R., Bergmann, J.S., Clement, V.W.C., Ober, K.J., Schewe, J., Adamo, S., McCusker, B., Heuser, S., Midgley, A., 2018. Groundswell : Preparing for internal climate migration (No. 124719). The World Bank.
Ross, P.H., 2019. Occupation aspirations, education investment, and cognitive outcomes: Evidence from Indian adolescents. World Dev. 123, 104613. https://doi.org/10.1016/j.worlddev.2019.104613
Ruiz, C., Hernández, B., 2014. Emotions and coping strategies during an episode of volcanic activity and their relations to place attachment. J. Environ. Psychol. 38, 279–287. https://doi.org/10.1016/j.jenvp.2014.03.008
Ruyssen, I., Salomone, S., 2018. Female migration: A way out of discrimination? J. Dev. Econ. 130, 224–241. https://doi.org/10.1016/j.jdeveco.2017.10.010
Sampson, R.J., Raudenbush, S.W., Earls, F., 1997. Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy. Science 277, 918–924. https://doi.org/10.1126/science.277.5328.918
Schewel, K., 2020. Understanding Immobility: Moving Beyond the Mobility Bias in Migration Studies. Int. Migr. Rev. 54, 328–355. https://doi.org/10.1177/0197918319831952
Slangen, A.B.A., Carson, M., Katsman, C.A., van de Wal, R.S.W., Köhl, A., Vermeersen, L.L.A., Stammer, D., 2014. Projecting twenty-first century regional sea-level changes. Clim. Change 124, 317–332. https://doi.org/10.1007/s10584-014-1080-9
Smajgl, A., Toan, T.Q., Nhan, D.K., Ward, J., Trung, N.H., Tri, L.Q., Tri, V.P.D., Vu, P.T., 2015. Responding to rising sea levels in the Mekong Delta. Nat. Clim. Change 5, 167–174. https://doi.org/10.1038/nclimate2469
Stigler, G.J., Becker, G.S., 1977. De Gustibus Non Est Disputandum. Am. Econ. Rev. 67, 76–90.
Storlazzi, C.D., Gingerich, S.B., Dongeren, A. van, Cheriton, O.M., Swarzenski, P.W., Quataert, E., Voss, C.I., Field, D.W., Annamalai, H., Piniak, G.A., McCall, R., 2018. Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. Sci. Adv. 4, eaap9741. https://doi.org/10.1126/sciadv.aap9741
Tanner, K., 2012. Place attachment and place-based security: the experiences of red and green zone residents in post-earthquake Kaiapoi (Research Dissertation). The University of Canterbury, Christchurch, New Zealand.

Tjaden, J., Auer, D., Laczko, F., 2019. Linking Migration Intentions with Flows: Evidence and Potential Use. Int. Migr. 57, 36–57. https://doi.org/10.1111/imig.12502
Twigger-ross, C.L., Uzzell, D.L., 1996. PLACE AND IDENTITY PROCESSES. J. Environ. Psychol. 16, 205–220. https://doi.org/10.1006/jevp.1996.0017
Van der Linden, S., 2015. The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. J. Environ. Psychol. 41, 112–124. https://doi.org/10.1016/j.jenvp.2014.11.012
Veszteg, R.F., Funaki, Y., Tanaka, A., 2015. The impact of the Tohoku earthquake and tsunami on social capital in Japan: Trust before and after the disaster. Int. Polit. Sci. Rev. 36, 119–138. https://doi.org/10.1177/0192512113509501
Vitousek, S., Barnard, P.L., Fletcher, C.H., Frazer, N., Erikson, L., Storlazzi, C.D., 2017. Doubling of coastal flooding frequency within decades due to sea-level rise. Sci. Rep. 7, 1399. https://doi.org/10.1038/s41598-017-01362-7
Wachinger, G., Renn, O., Begg, C., Kuhlicke, C., 2013. The Risk Perception Paradox—Implications for Governance and Communication of Natural Hazards. Risk Anal. 33, 1049–1065. https://doi.org/10.1111/j.1539-6924.2012.01942.x
West, E.G., McKee, M., 1983. De Gustibus Est Disputandum: The Phenomenon of "Merit Wants" Revisited. Am. Econ. Rev. 73, 1110–1121.
Whitt, S., Wilson, R.K., 2007. Public Goods in the Field: Katrina Evacuees in Houston. South. Econ. J. 74, 377–387. https://doi.org/10.2307/20111973
Williams, A.M., Baláž, V., 2012. Migration, Risk, and Uncertainty: Theoretical Perspectives. Popul. Space Place 18, 167–180. https://doi.org/10.1002/psp.663
Williams, D.R., Vaske, J.J., 2003. The Measurement of Place Attachment: Validity and Generalizability of a Psychometric Approach. For. Sci. 49, 830–840.
Willox, C., Harper, S.L., Ford, J.D., Landman, K., Houle, K., Edge, V.L., Rigolet Inuit Community Government, 2012. "From this place and of this place:" climate change, sense of place, and health in Nunatsiavut, Canada. Soc. Sci. Med. 1982 75, 538–547. https://doi.org/10.1016/j.socscimed.2012.03.043
World Medical Association, 2013. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA 310, 2191–2194. https://doi.org/10.1001/jama.2013.281053
Zander, K.K., Richerzhagen, C., Garnett, S.T., 2019. Human mobility intentions in response to heat in urban South East Asia. Glob. Environ. Change 56, 18–28. https://doi.org/10.1016/j.gloenvcha.2019.03.004
Zscheischler, J., Westra, S., van den Hurk, B.J.J.M., Seneviratne, S.I., Ward, P.J., Pitman, A., AghaKouchak, A., Bresch, D.N., Leonard, M., Wahl, T., Zhang, X., 2018. Future climate risk from compound events. Nat. Clim. Change 8, 469–477. https://doi.org/10.1038/s41558-018-0156-3

4 *Repeated information of benefits reduces COVID-19 vaccination hesitancy: Experimental evidence from Germany*[*]

Maximilian N. Burger, Matthias Mayer, Ivo Steimanis[1†]

Abstract

Many countries, such as Germany, struggle to vaccinate enough people against COVID-19 despite the availability of safe and efficient vaccines. With new variants emerging and the need for booster vaccinations, overcoming vaccination hesitancy gains importance. The research to date has revealed some promising, albeit contentious, interventions to increase vaccination intention. However, these have yet to be tested for their effectiveness in increasing vaccination rates. We conducted a preregistered survey experiment with N = 1,324 participants in Germany in May/June 2021. This was followed by a series of emails reminding participants to get vaccinated in August and concluded with a follow-up survey in September. We experimentally assess whether debunking vaccination myths, highlighting the benefits of being vaccinated, or sending vaccination reminders decreases hesitancy. In the survey experiment, we find no increase in the intention to vaccinate regardless of the information provided. However, communicating vaccination benefits over several weeks reduced the likelihood of not being vaccinated by 9 percentage points, which translates into a 27% reduction compared to the control group. Debunking vaccination myths and reminders alone also decreased the likelihood, yet not significantly. Our findings suggest that if soft governmental interventions such as information campaigns are employed, highlighting benefits should be given preference over debunking vaccination myths. Furthermore, it seems that repeated messages affect vaccination action while one-time messages might be insufficient, even for increasing vaccination intentions. Our study highlights the importance of testing interventions outside of survey experiments that are limited to measuring vaccination intentions – not actions – and immediate changes in attitudes and intentions – not long-term changes.

Keywords: Vaccination hesitancy, vaccination intentions, vaccination action, survey experiment, repeated information

---

[*] This essay has been published as: Burger, M. N., Mayer, M., Steimanis, I., 2022. Repeated information of benefits reduces COVID-19 vaccination hesitancy: Experimental evidence from Germany. PLOS ONE 17, e0270666. https://doi.org/10.1371/journal.pone.0270666

[1] Authors affiliation: School of Economics and Business, Universität Marburg, Germany

[†] Correspondence: Maximilian N. Burger, maximilian.burger@wiwi.uni-marburg.de

Acknowledgments: We thank Moritz Fritschle for his assistance in designing and operationalizing the study, our colleagues for their valuable comments, and all the participants who took part in the study.

Funding: Data collection was supported by The Deutsche Forschungsgemeinschaft (grant number: STE 3083/1-1). Authors declare no competing interests.

Ethics statement: The study design and field implementation were designed and conducted according to the World Medical Association Declaration of Helsinki (2013). The study received ethical approval from the German Association for Experimental Economic Research e.V. (GfeW, no. IC4Gnr8z). All respondents gave their informed consent and were free to resign from the study at any time.

Data and materials availability: The replication package containing the raw data and Stata code can be accessed via GitHub (https://github.com/IvoSteimanis/covid19_PLOS)

4.1 Introduction

The COVID-19 pandemic prompted global research leading to the development of several vaccines in record time. At the same time, countries like Germany are struggling to have enough people vaccinated to relieve pressure on their healthcare systems. The prevalence of certain ideologies in Germany – such as anthroposophy (Fournet et al., 2018), homeopathy (Altenbuchner et al., 2021), and far right-wing supporters (Desson et al., 2021) – likely provided fertile grounds for skepticism towards COVID-19 vaccines. As of December 2021, almost 27% of Germans were still unvaccinated with vaccination rates plateauing since fall (RKI, 2021a). Meanwhile, vaccine protection is waning (Naaber et al., 2021; Nordström et al., 2021), and new variants are expected to lead to further waves of infections that could bring public life to a standstill again (Eydlin et al., 2021). To decrease the spread of COVID-19 and the likelihood of the virus mutating, the German government launched information campaigns to highlight the benefits of vaccination and to combat the spread of vaccination myths. We mimic these two types of intervention in a real-world experiment to assess whether such information campaigns are effective in increasing vaccination rates.

Vaccination hesitancy – the delay in accepting or refusing vaccines despite their availability (MacDonald, 2015) – has been extensively researched prior to COVID-19. Decades of vaccination hesitancy research has shown that hesitancy is complex, multifaceted, and context specific (for an overview see Dubé et al., 2015). A large share of variation in hesitancy can be explained by differences in (i) sociodemographic characteristics; (ii) cultural, institutional, and political factors; and (iii) psychological factors (Dubé et al., 2013; Falagas and Zarkadoulia, 2008; Larson et al., 2014; Rainey et al., 2011; Schmid et al., 2017; Williams, 2014). However, there is not one universal factor that consistently explains hesitancy as determinants vary not only across countries and vaccine types but also over time.

Research on hesitancy towards COVID-19 vaccines shed further light on the connection of the three broader categories researched in vaccination hesitancy in general. First, sociodemographic characteristics such as age, gender, affluency, and education were associated with vaccination hesitancy in many different contexts (Argote Tironi et al., 2021; Cascini et al., 2021; Daly and Robinson, 2021; Edwards et al., 2021; Lazarus et al., 2021; Neumann-Böhme et al., 2020; Petersen et al., 2021; Ruiz and Bell, 2021; Troiano and Nardi, 2021). Second, cultural, political, and institutional differences such as lower trust in authorities and support of populist views were also found to correlate with higher COVID-19 hesitancy (Cascini et al., 2021; Edwards et al., 2021; Kerr et al., 2021; Lindholt et al., 2021; Murphy et al., 2021). Third, psychological factors such as higher risk appraisal, greater psychological distress from the pandemic, and stronger other regarding

preferences have been consistently shown to correlate with lower hesitancy (Chevallier et al., 2021; Gates et al., 2021; Gerretsen et al., 2021; Murphy et al., 2021; Wismans et al., 2021).

While sociodemographic characteristics as well as cultural, institutional, and political factors are important to explain how hesitancy emerges, it is difficult, sometimes even impossible, to change them. Policies targeting people's attitudes, perceptions, and opinions are likely more fruitful in reducing hesitancy quickly. Moreover, doubts regarding the safety, effectiveness, and benefits of the COVID-19 vaccines on the one hand and an underestimation of the risk of infection and severe illness on the other have been shown to be the most prominent reasons for hesitancy across many countries (Cascini et al., 2021; Chevallier et al., 2021; Gates et al., 2021; Lindholt et al., 2021; Solís Arce et al., 2021; Thunström et al., 2021). One approach to mapping these psychological determinants is the 5C model, which elicits people's Confidence in the safety and efficacy of the vaccine, Complacency about the risk of infection, Constraints that prevent one from vaccinating, Calculation of one's own costs and benefits, and the perceived Collective responsibility to vaccinate (Betsch et al., 2018). Furthermore, analysis suggests that many psychological factors determining hesitancy towards COVID-19 vaccines are mediated via the 5Cs (Wismans et al., 2021).

One threat to people's confidence in the safety and effectiveness of vaccination is fake news and misinformation. While empirical evidence suggests that exposure to vaccination myths increases vaccination hesitancy (Davis et al., 2021; Loomba et al., 2021; Thaker and Subramanian, 2021), far less is known about how to counteract the resulting hesitancy. Some studies have found that providing accurate information to debunk vaccination myths increase vaccination intentions (Argote Tironi et al., 2021; Davis et al., 2021; Petersen et al., 2021; Pfattheicher et al., 2021), while others have found no effect (Kachurka et al., 2021; Kerr et al., 2021). The impact of emphasizing benefits remains similarly contested, with some studies finding evidence that highlighting benefits increases intentions (Ashworth et al., 2021; Mottelson et al., 2021; Pfattheicher et al., 2021) while others do not (Dai et al., 2021; James et al., 2021; Kachurka et al., 2021; Rabb et al., 2021; Sprengholz et al., 2021). These contradicting findings might be explained by country-specific differences at the time of data collection, such as the epidemiological situation or information about the vaccines dominating the news at that time. Furthermore, many studies were conducted before vaccines were available in 2020, and with the exception of Dai et al. (2021) all studies cited here had to rely on vaccination intentions instead of actual behavior. To assess whether information campaigns reduce hesitancy, studies are needed that examine their impact on vaccination intention and vaccination actions over time. Beyond these interventions, the convenience of vaccination – such as ease of access and availability – is suggested to reduce hesitancy as well (Badr et al., 2021; Eshun-

Wilson et al., 2021). Moreover, vaccination reminders have been shown to increase COVID-19 vaccination rates (Dai et al., 2021).

This study investigates how debunking vaccination myths and highlighting benefits in combination with sending vaccination reminders can affect vaccination intentions and actions over time. We expect both debunking myths and highlighting benefits to increase participants' intention to get vaccinated and that repeated debunking of vaccination myths as well as repeated highlighting of vaccination benefits will reduce inaction. First, we ran a preregistered survey experiment in Germany in May/June 2021, testing the effects of debunking vaccination myths and highlighting benefits on vaccination intentions. This was followed by a series of emails reinforcing the information treatments in the survey experiment and concluded with a follow-up survey three months later in September 2021 to measure whether participants were vaccinated. We find that one-time exposure to information, irrespective of the content, does not increase vaccination intentions in the survey experiment. However, communicating vaccination benefits over several weeks increased the likelihood of taking action towards vaccination by 27% compared to the control group, while debunking vaccination myths had no significant effect. Our findings highlight the importance of testing interventions outside of survey experiments that are limited to measuring vaccination intentions – not actions – and immediate changes in attitudes and intentions – not long-term changes. Attitudes, in particular, have been shown to take time to change; see, for example, Albarracin & Shavitt (Albarracin and Shavitt, 2018) and Bohner & Dickel (Bohner and Dickel, 2011). In addition, our explorative analysis suggests that participants that did not take any action towards being vaccinated are deeply entrenched in their belief that COVID-19 vaccines are unnecessary and harmful. Only about 10% of these participants reported being vaccinated if financially incentivized, and even fewer reported getting vaccinated if sanctioned.

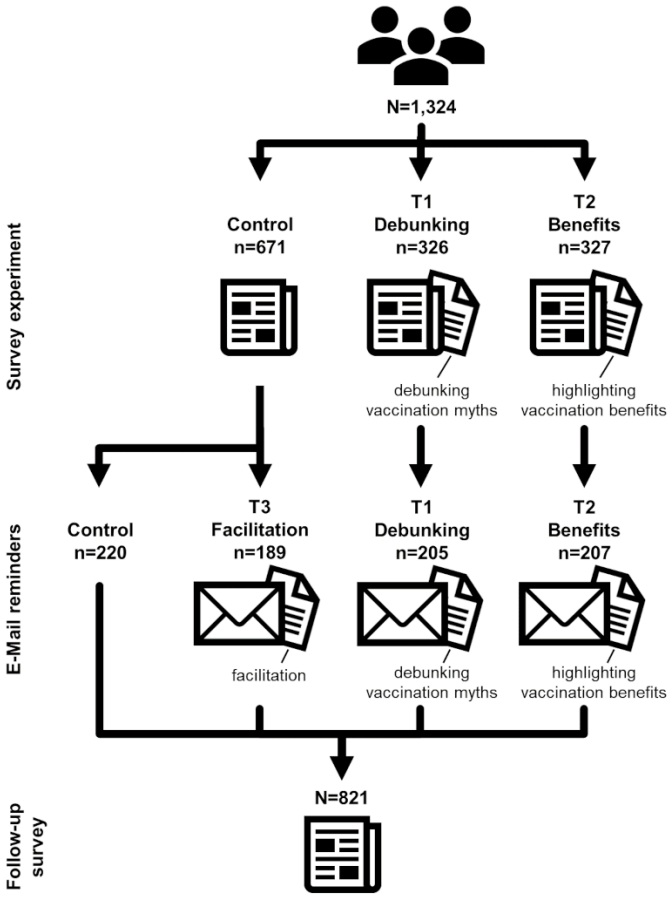
4.2 Methods

4.2.1 Experimental design

We conducted a pre-registered experiment in Germany between May and September 2021, with 1,324 unvaccinated participants to measure the extent to which information and reminders can reduce vaccination hesitancy. We proxy vaccination hesitancy by the variables vaccination intention and vaccination inaction described below. The study was implemented in three phases (see Fig 4.1). From May 25 to June 2, we conducted a survey experiment to examine the effectiveness of debunking vaccination myths (T1: Debunking) or highlighting benefits (T2: Benefits) on vaccination intention. Throughout August, participants in the treatment groups received one email per week, four in total, reminding

them to get vaccinated. The emails contained information for participants on where to register for a vaccination appointment and, depending on participants' treatment group, additional information either further debunking vaccination myths or highlighting the benefits of vaccination. In addition, a facilitation treatment (T3: Facilitation) was implemented at this stage in which half of the participants from the control group also received vaccination reminder emails including information on where to register for an appointment. Between September 6 and 18 we conducted a follow-up survey to record participants' vaccination action. We chose this period for our study as restrictions on applications for vaccination appointments were lifted in Germany in May 2021. Supplementary section C.3 provides more detailed background information on the discussion and implementation of policies in Germany at the time of the study. In the subsequent months, with much of the demand for vaccination met, waiting lists and sometimes even appointments became obsolete in vaccination centers. To ensure that all participants had ample opportunity to vaccinate, we waited until September to complete our experiment through conducting the follow-up survey.

Fig. 4.1 Study Design & Treatment Groups



Note: The three study phases are presented in rows, the treatment conditions in columns, and the *n* refers to the number of observations in each phase and treatment group. In the survey experiment, participants were randomly assigned to one of three groups: control, debunking (T1), or benefits (T2). Half of the participants in the control group were then randomly assigned to receiving facilitation emails (T3). Of the 1,324 participants from the survey experiment, 821 (62%) returned the follow-up survey.

4.2.1.1 Treatments

In the survey experiment (May/June), 1,324 participants were randomly assigned to one of three treatment conditions: Control, T1 Debunking, or T2 Benefits. The exact presentation of information provided in each condition is reported in C.12 supplementary materials. In the debunking treatment, participants were presented with a brief explanation on why COVID-19 vaccines were approved quicker than other vaccines without skipping any steps in the examination phase, what the efficacy of a vaccine means in terms of protection of the vaccinated person, how well the side effects are researched, and why vaccines do not interfere with people's DNA. Participants allocated to the benefits treatment were provided information on the benefits of vaccination including both individual and collective benefits such as being vaccinated protects one from severe COVID-19 infections, helps to protect others who cannot get vaccinated, lifts all contact restrictions and curfews, and eliminates quarantine requirements when traveling. Both information sets were composed to be as similar as possible to each other in appearance and amount of information to be processed. We designed the treatments to mimic campaigns implemented by governments and organizations. The German government – among others – provided corrective information debunking widespread misbeliefs on the COVID-19 vaccination on the official website (n.d.). In addition, the Federal Ministry for Health of Germany set up a website highlighting the benefits for oneself and others of the vaccination (n.d.). We cover these two campaigns in the survey experiment and complement them with the facilitation treatment introduced in the follow-up mails. For this, we randomly assigned half of the participants from the control group to the facilitation treatment. The aim of this treatment was to mimic governmental efforts to increase the convenience of vaccination by invitations to (mobile) vaccination centers.

The emails sent between the survey experiment and follow-up survey contained a reminder to get vaccinated, further information regarding the respective treatment of the survey experiment (only T1 Debunking, T2 Benefits), and information on where local vaccination appointments could be made online or by phone. The pure control group did not receive any emails.

4.2.1.2 Hypotheses

The aim of our study was to assess the efficacy of policies aiming to increase vaccination rates both recommended by the literature and implemented by governments at a time when vaccinations became readily available. Based on previous empirical results, we expected both the debunking and benefits treatment to increase participants' intention to be vaccinated in comparison to the control group leading to our hypotheses (survey experiment):

- *H1.1: Receiving information debunking vaccination myths increases the intention to get vaccinated.*
- *H1.2: Receiving information highlighting the benefits of the vaccination increases the intention to get vaccinated.*

In addition, we expected that sending vaccination reminders and making people aware of information facilitating vaccination enrollment, would reduce inaction (follow-up survey):

- *H2.1: Receiving emails providing information where and how to register for vaccination increase the probability of getting vaccinated*

Lastly, we expected that repeated information provision, either debunking vaccination myths or highlighting vaccination benefits, in combination with facilitation will reduce inaction:

- *H2.2: Receiving debunking information emails increase the probability of getting vaccinated*
- *H2.3: Receiving emails highlighting the benefits of the vaccination increase the probability of getting vaccinated*

4.2.2 Measurement variables

Our main outcome variables are (i) intention to get vaccinated and (ii) participants' vaccination action. We measured participants' intention by asking whether they would vaccinate if they had the opportunity on a 7-point Likert scale ranging from "definitely would not" to "definitely would" (see C.12 for detailed materials). In addition, we adopted Betsch et al.'s (2018) five psychological antecedents of vaccination scale (5C scale): Confidence that the vaccine is safe and effective, Complacency about the risk of infection, Constraints that prevent one from vaccinating, Calculation of one's own costs and benefits, and the perceived Collective responsibility to vaccinate. In May/June 2021, most vaccination centers administered only vector vaccines (e.g., AstraZeneca and Johnson & Johnson), and some people were waiting for mRNA vaccines (e.g., BioNTech/Pfizer and Moderna) to become available before registering for a vaccination appointment. Therefore, we recorded participants' Confidence in mRNA and vector vaccines separately. Both intention to get vaccinated and the 5C scale were measured after the treatment to avoid demand effects.

To record participants' vaccination action, we asked them if they were fully vaccinated, partially vaccinated, had a vaccination appointment, were on a waiting list for an appointment, or had taken no actions to vaccinate so far. Vaccination action was assessed prior to the treatment in the survey experiment. As participants who reported already being fully or partially vaccinated were excluded from the May/June 2021 survey experiment,

only the following actions were recorded: having an appointment, being on a waiting list, or not yet having taken an action. Vaccination action was also assessed in the follow-up survey. From this vaccination action, we deduce the binary variable inaction which takes the value 1 if no action was taken and 0 otherwise.

As explanatory variables, we recorded participants' risk-perception, anticipated regret of (not) getting vaccinated, emotional response to COVID-19, experiences with previous vaccinations, and dogmatism. *Risk perception* was assessed in three steps. First, we asked participants a series of questions about the likelihood of infection, the severity of the disease, and long-term consequences, such as long COVID ($\alpha = .71$). Based on these responses we ranked their perception of risk to themselves and others on a scale from 0 "no risk" to 100 "high risk." Participants were then asked to correct their ratings if they felt misrepresented by it. Finally, the average of the two scores was taken to determine the risk perception score used in the analysis (see B.6. for details).

Anticipated regret was measured, following Brewer et al. (2016), by asking participants whether they would regret vaccination if they later experienced side effects and whether they would regret not being vaccinated if they later became seriously ill with COVID-19. Responses for both questions were recorded on a 7-point Likert scale. To construct the net-anticipated regret score, the score from the first question was subtracted from the score of the second question.

To record participants' *emotional response to COVID-19*, we asked them how strongly they feel upset, alarmed, nervous, attentive, or anxious when thinking about COVID-19 on a scale from 1 "not at all" to 7 "extremely" for each emotion respectively. In the analysis, we control for the average over all five emotions ($\alpha = .88$).

Dogmatism – the tendency to rigidly, uncritically adhere to beliefs – was assessed using a condensed version of Altemeyer's (2002) dogmatism scale. Responses towards the 9 items are compiled into an index where higher values are associated with a more dogmatic mindset ($\alpha = .78$). All measurements were pre-tested for their clarity and validity in an online survey with 575 students at the University of Marburg in May 2021 (see B.1 for details).

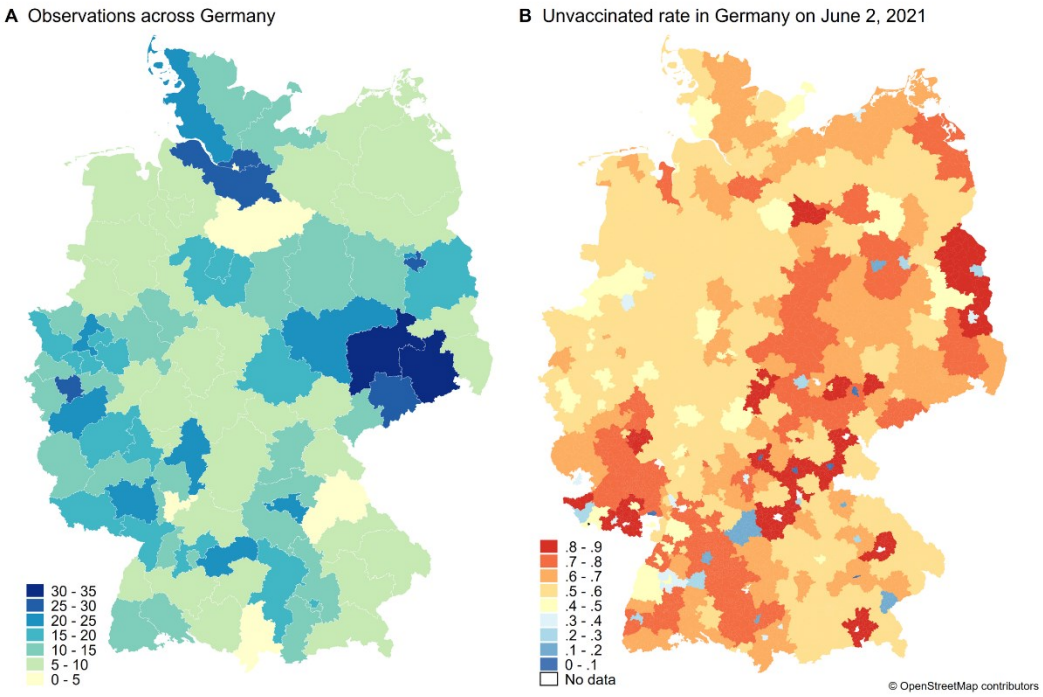
4.2.3 Sample

In total, 1,623 people completed the online survey experiment in May/June and 987 participants completed the follow-up survey in September. Participants were recruited by Respondi via its online opt-in panel on the platform Mingle and directed to our surveys. In accordance with Respondi's guidelines, participants received .75 euros per survey, each of which took on average 14 minutes to complete. Surveys were generated using the software SoSci Survey (Leiner, 2021) and made available to participants via www.soscisurvey.de.

Following our pre-registered exclusion criteria, we excluded participants who rushed through either of the surveys in less than 5 minutes, showed signs of inattention, or reported not having answered all questions in an attentive manner. We also excluded participants with a discrepancy greater than one year in the reported age or specified different genders between surveys. Thus, the final sample includes 1,324 participants for the survey experiment and 821 participants for the follow-up survey. Our results are robust to the exclusion criteria, although excluded participants do differ from the remaining sample in some respects. For example, excluded participants tend to be male, younger, have lower net anticipated regret, and are less likely to intend to vaccinate (see C.4 for details). In 4.4.3 and C.5 supplementary materials, we discuss how attrition might affect our results.

Due to the requirement of being unvaccinated to participate, it appears that we have a higher proportion of participants from areas with lower vaccination rates. Fig. 4.2A shows where our participants come from, Fig. 4.2B shows the proportion of unvaccinated individuals across Germany on June 2, 2021. Although the origin of our participants and the vaccination rate do not match perfectly, there is a distinct overlap in the areas where we sampled more participants (dark blue) and where many people are unvaccinated (dark red). In addition, our sample reflects the age distribution of the unvaccinated population in Germany at that time (see C.8 supplementary materials).

Fig. 4.2 Sample distribution over Germany



Note: Panel A shows where study participants are from. We asked participants for the first two digits of their area code and colored them according to the number of participants in each area. Panel B shows the proportion of unvaccinated individuals in Germany as of June 2, 2021. The map was created using publicly available vaccination data from the RKI (RKI, 2021b) and shows the proportion of unvaccinated individuals by administrative code (AGS) for which the number of vaccinations was reported. For population data, we use data from the 2011 Census from the Federal Statistical Office Germany (Destatis, 2011). Because area

codes and administrative area codes do not completely overlap, there are slight discrepancies in the areas highlighted in panels A and B. Both maps were created with Stata 16 using shapefiles from OpenStreetMap, available under the Open Database: https://www.openstreetmap.org/copyright (OpenStreetMap, 2017).

Compared to the general population, we sampled fewer elderly people (aged 60 and above), since they were prioritized for vaccination in the months before data collection. In terms of gender, our sample is not significantly different from that of the general population. Slightly more than 50% of our participants are female and their age structure roughly follows the general age distribution of Germany under 50 years. In our sample (Table 4.1), over 40% are married and 29% and 26% graduated from high school and university, respectively.

Table 4.1 Summary statistics

	Mean	SD	Min	Max
Outcome variables				
Vaccination intention: mRNA	5.17	2.34	1	7
Vaccination intention: Vector	3.32	2.33	1	7
5C: Confidence mRNA	4.71	1.97	1	7
5C: Confidence Vector	3.91	1.86	1	7
5C: Constraints	2.17	1.33	1	7
5C: Complacency	3.19	1.79	1	7
5C: Calculation	5.08	1.60	1	7
5C: Collective responsibility	5.05	1.81	1	7
Vaccination hesitancy (=1)	0.52	0.50	0	1
Explanatory variables				
Denied other vaccines	0.14	0.35	0	1
Index: Covid19 risk perception	39.41	22.46	0	100
Index: Emotional response to COVID-19	3.61	1.48	1	7
Net anticipated regret (no vaccination – vaccination)	0.95	4.00	-6	6
Index: Dogmatism	3.95	0.96	1	7
Socio-economic variables				
Female	0.51	0.50	0	1
Age: <30	0.20	0.40	0	1
Age: 30-39	0.13	0.33	0	1
Age: 40-49	0.22	0.41	0	1
Age: 50-64	0.37	0.48	0	1
Age: 65+	0.08	0.27	0	1
Secondary school: “Hauptschulabschluss”	0.11	0.32	0	1
Secondary school: “Realschulabschluss”	0.35	0.48	0	1
High school: “Fach & allg. Hochschulberechtigung“	0.28	0.45	0	1
University degree	0.26	0.44	0	1
HH Income: < 1,001€	0.11	0.32	0	1
HH Income: 1,001€ - 3,000€	0.50	0.50	0	1
HH Income: 3,001€ - 4,500€	0.25	0.43	0	1
HH Income: > 4,500€	0.13	0.34	0	1
Household members aged 0-14 years	0.26	0.59	0	4
Household members above 14 years	1.49	1.26	0	23
Married	0.41	0.49	0	1
Observations	1,324			

Notes: Table 4.1 shows mean, SD, minimum and maximum values of outcome, explanatory, and control variables. More details on sample characteristics are provided in C.7 supplementary materials.

4.2.4 Statistical analysis

Our study design, data collection, and analysis were pre-registered on AsPredicted (Ref. 66735). We use ordinary least square regression to estimate treatment effects on vaccination intention and action with heteroskedasticity robust standard errors. Due to the

binary outcome variable for vaccination action, we used non-linear probability models to estimate treatment effects as robustness checks, reported in C.9 supplementary materials. For the main results, we control for a set of pre-specified covariates to improve precision of our treatment estimates. These covariates include the participants' socioeconomic status, such as age, highest completed education, marital status, household income adjusted by household size (see C.6 for details), perceived health status, and whether participants ever rejected a vaccination before. Based on our power calculation used to determine sample sizes, we should be able to detect small effect sizes for vaccination intention and medium effect sizes for vaccination action. All analyses were conducted with Stata version 16.0.

4.2.5 Ethics statement

The study received ethical approval from the German Association for Experimental Economic Research e.V. (GfeW, no. IC4Gnr8z). The welcome page of our survey informed participants about the guidelines of ethical empirical research: voluntariness, compensation, benefits, and anonymity. In case they had any questions or concerns they could contact the corresponding author at any time via email (exact wording is reported in C.12 supplementary materials). In addition, participants were provided with clear information regarding the purpose, duration, and scope of the study before giving their written informed consent. Participants had to state that they are (i) 18 or older, (ii) agree to receive up to four emails, (iii) read and understood the information on ethical empirical research, and (iv) are willing to participate in this study. All data were handled confidentially, stored safely, and we ensured that the anonymous survey experimental data are kept separately from non-anonymous payments data.

4.3 Results

The results section is organized as follows. First, we look at treatment effects of one-time messages debunking vaccination myths or highlighting vaccination benefits on vaccination intentions in the survey experiment (H1.1 and H1.2). Second, we analyze the effects of the repeated information provision by email on vaccination actions reported in the follow-up survey using the balanced panel dataset (H2.1, H2.2, and H2.3).

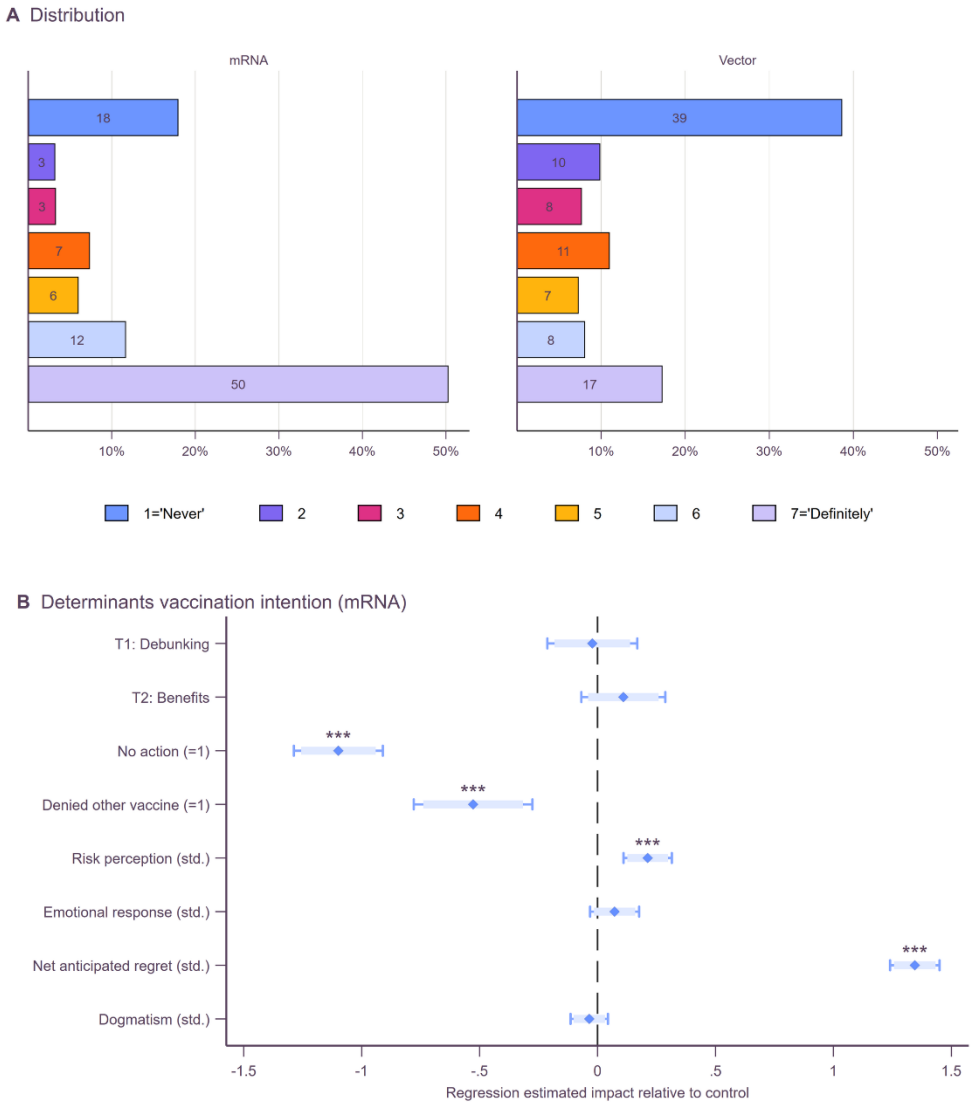
4.3.1 Survey experiment: Treatment effects on vaccination intentions and 5C

Our findings show a clear discrepancy in vaccination intentions between mRNA (Pfizer, Moderna) and vector (AstraZeneca, Johnson & Johnson) vaccines. While 50% of participants report that they would definitely be vaccinated with a mRNA vaccine, only 17% would definitely accept a vector vaccine (Fig 4.3A). On average, 62% of participants

intend to get vaccinated (scores above 5) with mRNA vaccines but only 25% do with vector vaccines. For vector vaccines, the share of participants (49%) who do not intend to get vaccinated (score below 3) is more than double compared to mRNA vaccines (21%). Overall, 54% of participants prefer mRNA over vector vaccines, with 44% being indifferent, and 2% stating a preference for vector vaccines. The average intention for vector vaccines is 1.8 points lower on the 7-point Likert scale than for mRNA vaccines (T-Test diff. = 1.85, $t_{1,323} = 30.12$, $p < .001$).

In the following analysis of treatment effects, we report only intentions to vaccinate with mRNA vaccines because at the time of our study people could freely choose their vaccines in Germany and almost all participants either had a clear preference for mRNA vaccines or were indifferent. Furthermore, there were no shortages of mRNA vaccines in Germany at that time. Results for intentions to vaccinate with vector vaccines are reported in C.9 supplementary materials.

Fig. 4.3 Vaccination intentions



Notes: Panel A shows vaccination intentions across treatments separately for mRNA and vector vaccines measured using 7-point Likert scales. Panel B plots regression estimates with vaccination intention (mRNA) as the dependent variable from ordinary least square regressions controlling simultaneously for the plotted

variables and additionally for gender, age, education, adjusted household income, and marital status. Heteroskedasticity robust standard errors were used to compute 95% (thin bars) and 90% (thick bars) confidence intervals. Full regression outputs are reported in C9, model 3 corresponds to the plotted estimates in panel B.

We start with testing the hypothesis of whether debunking vaccination myths (T1: Debunking) or highlighting the benefits of getting vaccinated (T2: Benefits) increase the intention to get vaccinated using multiple regression (Fig 4.3B). Contrary to our expectation, we find that neither the debunking treatment (coefficient ß = -.02, p = .819, 95%CI: -.21 to .17) nor the benefits treatment (ß = .11, p = .228, 95%CI: -.07 to .29) significantly increases participants' intentions to get vaccinated. One concern could be that respondents belonging to a priority group are more hesitant than other respondents as they had more time to get vaccinated but are not. Testing for this possibility we find no differences in treatment effects between priority and non-priority groups. Furthermore, respondents belonging to a priority group reported higher intentions than respondents without priority status, not lower. Beyond, we preregistered several heterogeneous effects but do not find any of them to be statistically significant. In all estimations, we additionally control for differences in covariates between treatment groups (see C.9 for additional results and robustness checks).

Further analyses show that socioeconomics are jointly significant but do not explain much of the variation in mRNA vaccination intentions (adj. R^2 = .025). Adding individual-level variables, for which we plotted the point estimates in Fig 4.3B, drastically increases the explained variance in intentions (adj. R^2 = .640). Especially net-anticipated regret of getting vaccinated compared to not getting vaccinated is a strong predictor for vaccination intention. A one SD increase in net-anticipated regret increases vaccination intentions by 1.3 points (ß = 1.35, p < .001, 95%CI: 1.24 to 1.45). In addition, participants who have not taken any steps towards getting vaccinated (ß = -1.10, p < .001, 95%CI: -1.29 to -.91) and participants who denied other vaccines in the past (ß = -.52, p < .001, 95%CI: -.78 to -.28) have lower intentions.

The analysis of treatment effects on the 5C is reported in C.9 supplementary materials. The factors captured by the 5C-scale are strongly correlated with the intention to get vaccinated – they jointly explain 74% of the variation in intentions (adj. R^2 = .737). Given that the treatments had no effect on the intention it is not surprising that we do not find a consistent effect of the treatments on the 5C.

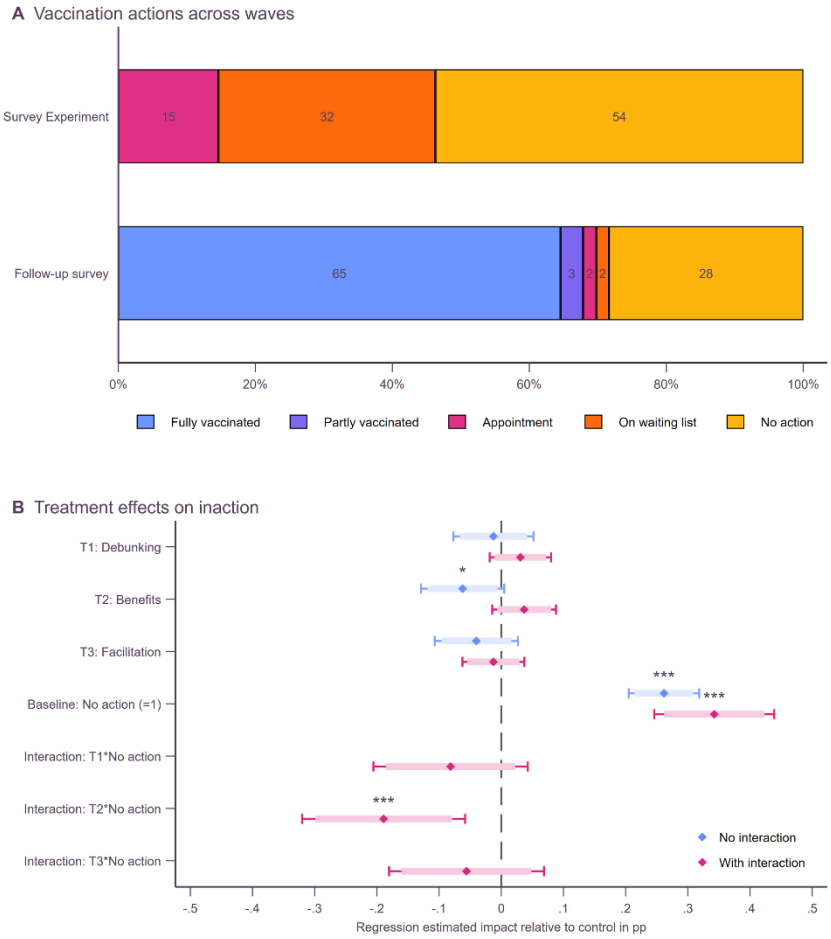
4.3.2 Follow-up survey: Treatment effects on self-reported vaccination (in)action

Next, we focus our analyses on participants' self-reported actions and test whether our treatments were successful in reducing inaction. For this we use the balanced panel dataset, that is, only include those who have participated both in the survey experiment and

follow-up survey. At the time of our first survey, half of the participants (52%) had not taken any actions towards getting vaccinated, 33% were on a waiting list, and only 15% already had an appointment (see Fig 4.4A). In the follow-up survey, 65% of participants were fully vaccinated, and 28% (n = 233) still had not taken any actions to get vaccinated. Only a few participants either were only partially vaccinated (3%), had an appointment (2%), or were on a waiting list (2%). Given this dichotomous outcome in self-reported vaccination actions in the follow-up survey, we use a binary specification of inaction for the analyses of treatment effects.

Fig 4.4B shows regression estimates from linear probability models predicting the likelihood of not having taken any action in the second wave. On average (blue estimates), the benefits treatment significantly reduced inaction by about 6 percentage points compared to the control group (ß = -.06, p = .07, 95%CI: -.13 to .00), while neither the debunking of false information (ß = -.01, p = .71, 95%CI: -.08 to .05) nor facilitation alone (ß = -.04, p = .24, 95%CI: -.11 to .03) had any significant effect. However, it seems intuitive that our treatments could only affect those who had not reported any actions in the survey experiment (orange estimates). Almost everyone who had reported to have taken action to get vaccinated in the survey experiment was fully vaccinated in the follow-up survey. Among those participants who had taken no actions to begin with, the benefits treatment reduced inaction by 19 percentage points compared to the control group (interaction ß = -.19, p < .001, 95%CI: -.32 to -.06). Using sample splits, we find that the benefits treatment has equal effects among socio-economic groups. Only women seem to react less to highlighting vaccination benefits than men (see C.9 supplementary materials). Even though the benefits treatment significantly reduced vaccination inaction, there is still a large proportion of participants who had not taken any actions to get vaccinated yet. In the discussion, we explore the determinants of this inaction in greater detail.

Fig. 4.4 Self-reported actions of the balanced panel



Note: Panel A shows the actions taken by participants across both waves. Panel B shows regression estimates with no action in the second wave as the dependent variable from linear probability models controlling for gender, age, education, adjusted household income, marital status, denied other vaccines, COVID-19 risk perception, emotional response, net anticipated regret, and dogmatism. Heteroscedasticity robust standard errors were used to compute 95% (thin bars) and 90% (thick bars) confidence intervals. Full regression outputs and robustness checks using non-linear Probit regression models are reported in C.9 supplementary materials.

4.4 Discussion

Our results suggest that repeatedly highlighting the benefits of getting vaccinated in combination with providing facilitation information decreases vaccination inaction while debunking vaccination myths or providing only facilitation information had no effect. Although many studies have found positive effects of providing factual information about the safety and efficacy of COVID-19 vaccines on reducing vaccination hesitancy, our results, in line with Ashworth et al. (2021), do not support this. Given that efficacy and safety concerns regarding the vaccine are the main driver of vaccination hesitancy, our results are surprising at first sight.

There are two plausible reasons why the debunking treatment did not decrease vaccination inaction. First, it could be that the information provided was already known to participants, as vaccine efficacy and safety have been discussed in the public since late 2020. The effect

of the debunking treatment on vaccination hesitancy is likely to be much smaller for someone who already feels well-informed than someone to whom this information is new. Indeed, we find that 33% (n = 138) of participants in the debunking treatment reported not being concerned with one of the aspects debunked in the treatment, and 23% (n = 74) were not concerned with any aspect. Second, prior opinions of participants might have been too strong to be changed significantly by the information provided. We find, for example, that participants in the debunking treatment do not feel better informed about the safety and efficacy of vaccines even after reading the information provided (T-Test diff. = .12, t_{868} = .97, p = .333, see C.9 supplementary materials). Furthermore, we asked participants in the debunking treatment to rate on 7-point Likert items to what degree (1 'not at all' to 7 'completely') the provided information reduced their concerns about the vaccines. Worryingly, concerned participants did not catch up to less concerned participants. They still feel significantly worse informed about the safety and efficacy of vaccines (7-point Likert item) than less concerned participants (T-Test diff. = -1.17, t_{285} = -5.96, p < .001) and have lower vaccination intentions (T-Test diff.= -1.94, t_{324} = -7.92, p < .001). Taken together, about one-third of the participants in the debunking treatment were not concerned regarding the COVID-19 vaccines, and the rest were not strongly convinced by the provided information. That could explain the lack of significant effects on reducing vaccination hesitancy.

In the following, we explore factors that explain why some participants are still not vaccinated and what policies could convince them to get vaccinated. These insights could help to understand the underlying reasons for inaction among these participants, as well as potential interventions to overcome vaccination hesitancy from a policy-makers perspective.

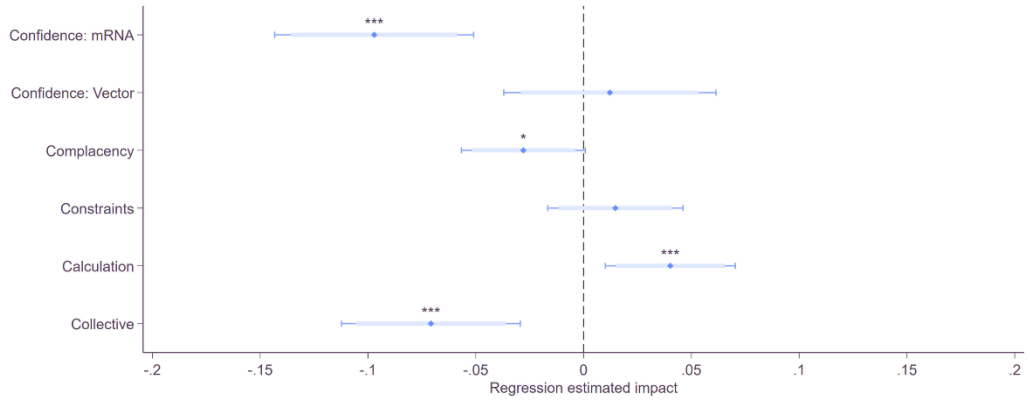
4.4.1 What determines being unvaccinated?

Participants who reported being on a waiting list or having an appointment in the first survey almost exclusively reported being fully vaccinated in the follow-up survey. Only eight participants who initially reported taking some action did not follow through with their plans to get vaccinated. Thus, in the following, we reduce the sample to only those participants who reported not having taken any actions to get vaccinated in the survey experiment and participated in the follow-up survey (n = 441). Within that sample, we check for correlations of different determinants on the likelihood of still not having any action in the second wave.

Using a stepwise modeling approach shows that socio-economic characteristics are jointly significant predictors of vaccination behavior, but they only explain 3% of the unique variation (adj. R^2 = .03). Additionally controlling for the 5Cs increases the explained

variation by more than tenfold (adj. R^2 = .35). The model controlling for other reasons such as COVID-19 risk perception, emotional response, dogmatism, and anticipated regret in addition socioeconomics explain about 25% of the variation (adj. R^2 = .25). However, when all factors are simultaneously controlled for, the model has the same explanatory power (adj. R^2 = .35) as the model only controlling for socioeconomics and the 5Cs – indicating the importance of the 5Cs (C.9). Fig 4.5 shows the effect each item of the 5Cs measured in the first wave has on self-reported vaccination behavior in the follow-up survey. Among the 5Cs, we find that higher Confidence in mRNA vaccines and Collective responsibility are correlated with a lower probability of inaction. Calculation, the degree to which individuals engage in extensive information seeking to weigh the risks of infection versus vaccination, is correlated with a higher probability of inaction. Participants who perceive COVID-19 as riskier (Complacency) also show slightly lower inaction. However, vaccination inaction does not correlate with structural or psychological barriers (Constraints) in our sample.

Fig. 4.5 Vaccination inaction and 5Cs

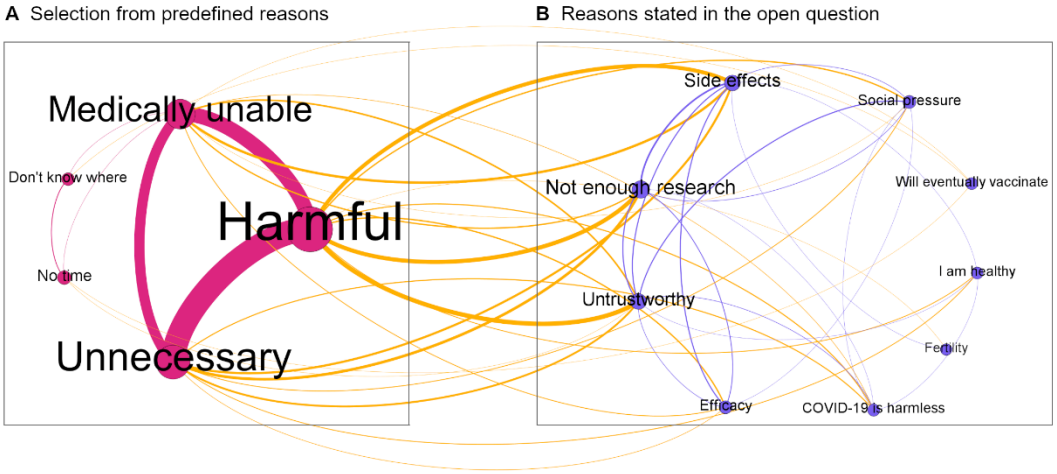


Note: Regression estimates for the five psychological antecedents of vaccination with the binary variable inaction in the second wave as the dependent variable from linear probability models are presented. We also control for gender, age, education, adjusted household income, marital status, denied other vaccines, COVID-19 risk perception, negative emotions, net anticipated regret, and dogmatism. Estimates are obtained from multiple least square regressions with robust standard errors: *** p < .01, ** p < .05, * p < .1. Full regression outputs are reported in C.9 supplementary materials.

While the aforementioned determinants provide useful insights into the underlying factors of inaction, we additionally allowed participants who had not taken any action yet to state their own reasons for not doing so in the follow-up survey (n = 233). Participants could tick pre-defined reasons as well as formulate their own reasons. Fig 4.6 shows the frequency with which each item was mentioned (size of nodes) and the frequency with which reasons were mentioned in conjunction with each other (size of edges, i.e., links between notes). The resulting network highlights the interconnectivity of reasons given for vaccination inaction. It suggests that participants who believe COVID-19 vaccines are harmful often also indicate that they are unnecessary. In addition, these participants tend to be concerned about the side effects, the amount of research, and share the view that the

government and the vaccination commission are not trustworthy. Finally, a surprisingly high proportion of participants also said they could not be vaccinated for medical reasons. Whether this is true or a result of overestimating the side effects, we can only speculate.

Fig. 4.6 Reasons stated for vaccination inaction



Note: Participants were asked about the reasons why they did not vaccinate. We categorized the reasons listed and highlighted which reasons were mentioned together. Panel A shows the relationship between pre-defined reasons participants could choose from in blue. Panel B shows the relationship of reasons that participants additionally mentioned in an open text box in orange. Connections between pre-defined and self-stated reasons are illustrated in green. The network was illustrated with Gephi 0.9.2.

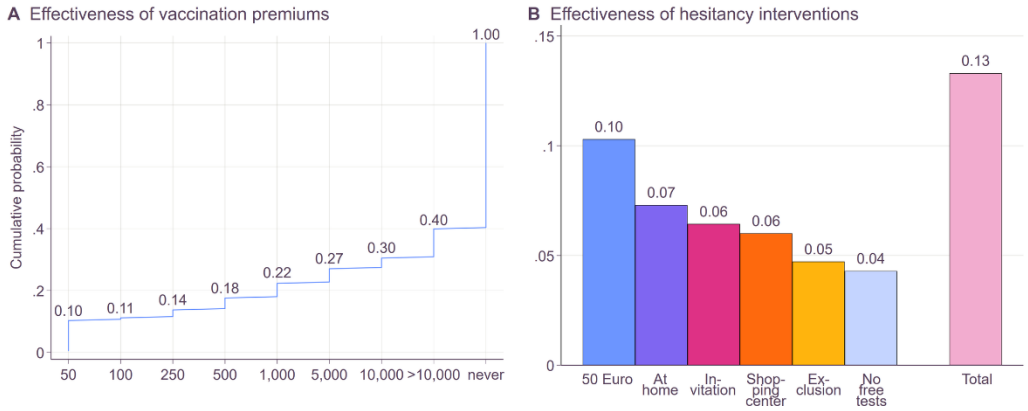
Comparing the results from the self-stated reasons (Fig 4.6) with the correlates of vaccination inaction with the 5C factors (Fig 4.5) reveals that, if inactive participants are asked directly, they are more likely no name safety concerns (Confidence) and argue that the vaccine is not necessary (Complacency). Yet, the correlates also reveal that inactive participants are more concerned about the costs and benefits (Calculation) of getting vaccinated and less concerned about the collective well-being (Collective) compared to vaccinated participants. This might indicate why the benefits treatment but not the debunking treatment reduced inaction. Even if people could be convinced that COVID-19 vaccines are safe and effective, they nevertheless might still believe that they are unnecessary. In addition, inactive participants are much more skeptical towards the government and vaccination commission. Consequently, they are likely more skeptical towards any information in support of vaccines. Highlighting the benefits of vaccination might therefore prove to be a more effective approach as it directly affects the cost-benefit calculation.

Our results suggest that pure information provision – debunking vaccination myths, highlighting benefits, or facilitation – still leaves room for improvement in terms of reducing vaccination hesitancy in the population. A significant share of our participants, just as the in general German population, had not taken any vaccination action towards getting vaccinated at the time of the second survey. In the following, we explore the potential of further policies aiming to reduce vaccination hesitancy.

4.4.2 Incentives to convince the unvaccinated

Prominent policies that have been discussed in politics, tested in research, and/or employed by some countries are monetary incentivization, facilitation of vaccination (e.g., getting vaccinated at home, receiving an invitation for vaccination, getting vaccinated at a shopping center), and disadvantages for those unvaccinated (e.g., exclusion from public events, and discontinuation of free COVID-19 tests). To explore the efficacy of these policies in the German context, we asked hesitant participants, who have not taken any actions to get vaccinated yet, about their (hypothetical) willingness to get vaccinated if certain policies were implemented. Firstly, participants were asked about their willingness to accept a COVID-19 vaccine if provided a monetary incentive (Fig 4.7A). We started with an incentive of 50 Euros which continued to increase every time the participant declined. In line with results on the effectiveness of monetary incentives for actual vaccination rates from a Swedish sample (Campos-Mercade et al., 2021), we find that providing a modest monetary incentive of 50 Euros increases the acceptance. However, further increases have relatively little effect compared to the amounts offered, for example, a tenfold increase in the amount of money offered increased the willingness to vaccinate by a mere 8 percentage points.

Fig. 4.7 Effectiveness of interventions to decrease hesitancy



Note: Panel A shows the cumulative distribution of unvaccinated participants who would vaccinate given a certain vaccination premium. We asked if they would vaccinate if they would receive a 50 Euro premium. If not, we repeated the question and increased the premium sequentially. Panel B shows the share of unvaccinated participants who would vaccinate given a 50 Euro premium if someone would come to their home to vaccinate them if they received an invitation to get vaccinated if they could vaccinate in a shopping center, if unvaccinated people were excluded from public events, or if the government would stop providing free COVID-19 tests. The final column to the right shows the total share of participants who stated an intention to vaccinate in one of the 6 hypothetical interventions.

Furthermore, we asked participants whether they would vaccinate if any of the policies named above were implemented (Fig 4.7B). While monetary incentives appear to have the greatest impact, overall, only 13% of hesitant participants could be persuaded to vaccinate with any incentive listed, which would further increase the vaccination rate in our sample by 3.7 percentage points. Although these are only exploratory results, they also indicate

resistance to strong interventions such as exclusion and sanctions. Earlier studies found that strong interventions find little appreciation, especially among the hesitant (Eshun-Wilson et al., 2021), and may increase anger among the hesitant (Betsch and Böhm, 2016) possibly leading to behavior to regain their restricted freedom (Sprengholz et al., 2021). It has therefore been argued that governmental interventions aiming at increasing vaccination uptake need to be designed with great care (Omer et al., 2019). Some participants indeed stated concerns in the open comment section such as skepticism or resistance towards governmental action: "As long as the vaccination is advertised with bonus, financial or material, the whole story is suspect to me", "If I have made up my mind about something and did my independent research, then I don't change my opinion/attitude just because someone sends me something and above all thereby wants to talk me into something", "I don't want to be blackmailed" or "The pressure to vaccinate is getting stronger, the advertising for vaccinations is getting weirder, and the supplemental offerings are getting more insane". While others stated in the open comment section that they indeed decided in favor of vaccination due to outside pressure, the possibility that such measures produce resistance should be kept in mind.

4.4.3 Limitations

The results reported have some limitations. First, the vaccination action measured is self-reported. It has been argued that participants may behave differently once cues about appropriate behavior have been provided by the experimenter, that is, the experimenter demand effect (Zizzo, 2010). In our case, participants in the treatment conditions may have sensed that we deemed getting vaccinated as a desirable action and therefore stated to have been vaccinated more often in the treatment groups. Furthermore, if participants understood the aim of the study – that is, testing the efficacy of information provision in reducing vaccination hesitancy – they may have untruly reported being vaccinated (de Quidt et al., 2019). We tried to control for such distortion by asking participants to report the batch number of their vaccines. We find no difference in batch numbers reported across treatments (see C.10 supplementary materials). Furthermore, demand effects are possibly lower in online research where the contact between the experimenter and the participant is minimized. Lastly, the fact that we do not find significant treatment effects on vaccination intention in the survey experiment also hints at the absence of experimenter demand effects.

Second, a substantial part of participants did not return for the second survey (attrition of 38%), potentially threatening the internal validity of our results on vaccination inaction reported in Fig 4.4. We tested for both differences in attrition rates and selectivity in terms of baseline outcome measures. Regarding attrition rates, we find that participants from the control, debunk, and benefits groups were equally likely to return, while those in the

facilitation treatment were 6 percentage points less likely to return compared to the control group. To further understand whether attrition affects the internal validity of our results, we compare the mean baseline outcomes of control and treatment participants by return status (Ghanem et al., 2021), for details see C.5 supplementary materials. These comparisons make us confident that the follow-up results are internally valid as we find that participants who returned have similar baseline outcome values across control and treatment groups.

Third, our results should be carefully situated in the context in which our study was conducted when generalizing to the broader population or even different countries. The treatment interventions started when vaccines became widely available to the entire adult population in Germany (end of May 2021). Thus, our treatments might have produced different results if they were assessed at another time, for example before vaccines were available in 2020. In addition, vaccination rates in Germany (67%) at the time of the follow-up survey were comparable to German-speaking countries (63% and 62% in Austria and Switzerland respectively, EU average: 66%) but much lower compared to other European countries such as Portugal (87%), Spain (80%), or, Denmark (76%) on September 19, 2021 (Mathieu et al., 2021). Our results might therefore, be more transferable to countries with similar contexts, such as Austria and Switzerland. These German-speaking countries have substantial cultural, historical, and economic ties and share a similar system of federalism with mandatory universal health insurance (Desson et al., 2021, 2020; Paul et al., 2022). While all three countries had prompt and similar governmental responses to the COVID-19 outbreak (school closures, obligatory masks, enforce social distancing, free testing facilities, contact tracing, etc.) vaccination rates plateaued by the end of September 2021 despite readily available vaccines (Desson et al., 2021).

Lastly, the data is from an opt-in online panel provided by Respondi. While it seems representative for the German population in terms of age and gender, this might not be the case for people's willingness to get vaccinated. Indeed, comparing our sample to the rest of Germany reveals that study participants in the balanced panel were on average much more likely to get vaccinated within the study period than the general German population (increase in vaccination rate of 67.84% in our sample vs. 40% in the German population over the same time frame, see C.11). This could be due in part to selective attrition but we suspect it more likely represents ex-ante differences in the willingness to vaccinate of people in the opt-in Respondi pool compared to the general population.

4.5 Conclusion

Despite these limitations, our results show the potential of repeatedly informing people about the benefits of vaccination and facilitating the process to decrease vaccination hesitancy. Moreover, our explorative results suggest that providing relatively small monetary incentives could help to further increase vaccination rates. These findings could be important for guiding future vaccination campaigns to reduce the spread of and deaths related to COVID-19. Given the large proportion of people not yet vaccinated in many countries, waning vaccine protection, the emergence of new variants, and the requirement of booster vaccinations, the development of effective COVID-19 vaccination campaigns will remain important for the foreseeable future.

4.6 References

Albarracin, D., Shavitt, S., 2018. Attitudes and Attitude Change. Annu. Rev. Psychol. 69, 299–327. https://doi.org/10.1146/annurev-psych-122216-011911

Altemeyer, B., 2002. Dogmatic behavior among students: Testing a new measure of dogmatism. J. Soc. Psychol. 142, 713–721. https://doi.org/10.1080/00224540209603931

Altenbuchner, A., Haug, S., Schnell, R., Scharf, A., Weber, K., 2021. Impfbereitschaft von Eltern mit einem COVID-19-Vakzin: Die Rolle von Elternschaft und Geschlecht. Pädiatr. Pädologie 56, 230–234. https://doi.org/10.1007/s00608-021-00925-2

Argote Tironi, P., Barham, E., Zuckerman Daly, S., Gerez, J.E., Marshall, J., Pocasangre, O., 2021. Messages that increase COVID-19 vaccine acceptance: Evidence from online experiments in six Latin American countries. PLOS ONE 16, e0259059. https://doi.org/10.1371/journal.pone.0259059

Ashworth, M., Thunström, L., Cherry, T.L., Newbold, S.C., Finnoff, D.C., 2021. Emphasize personal health benefits to boost COVID-19 vaccination rates. Proc. Natl. Acad. Sci. 118, e2108225118. https://doi.org/10.1073/pnas.2108225118

Badr, H., Zhang, X., Oluyomi, A., Woodard, L.D., Adepoju, O.E., Raza, S.A., Amos, C.I., 2021. Overcoming COVID-19 Vaccine Hesitancy: Insights from an Online Population-Based Survey in the United States. Vaccines 9, 1100. https://doi.org/10.3390/vaccines9101100

Bendau, A., Plag, J., Petzold, M.B., Ströhle, A., 2021. COVID-19 vaccine hesitancy and related fears and anxiety. Int. Immunopharmacol. 97, 107724. https://doi.org/10.1016/j.intimp.2021.107724

Betsch, C., Böhm, R., 2016. Detrimental effects of introducing partial compulsory vaccination: experimental evidence. Eur. J. Public Health 26, 378–381. https://doi.org/10.1093/eurpub/ckv154

Betsch, C., Böhm, R., Chapman, G.B., 2015. Using Behavioral Insights to Increase Vaccination Policy Effectiveness. Policy Insights Behav. Brain Sci. 2, 61–73. https://doi.org/10.1177/2372732215600716

Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., Böhm, R., 2018. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PLOS ONE 13, e0208601. https://doi.org/10.1371/journal.pone.0208601

Boes, L., Boedeker, B., Schmich, P., Wetzstein, M., Wichmann, O., Remschmidt, C., 2017. Factors associated with parental acceptance of seasonal influenza vaccination for their children – A telephone survey in the adult population in Germany. Vaccine 35, 3789–3796. https://doi.org/10.1016/j.vaccine.2017.05.015

Bohner, G., Dickel, N., 2011. Attitudes and Attitude Change. Annu. Rev. Psychol. 62, 391–417. https://doi.org/10.1146/annurev.psych.121208.131609

Brewer, N.T., DeFrank, J.T., Gilkey, M.B., 2016. Anticipated Regret and Health Behavior: A Meta-Analysis. Health Psychol. Off. J. Div. Health Psychol. Am. Psychol. Assoc. 35, 1264–1275. https://doi.org/10.1037/hea0000294

Campos-Mercade, P., Meier, A.N., Schneider, F.H., Meier, S., Pope, D., Wengström, E., 2021. Monetary incentives increase COVID-19 vaccinations. Science 374, 879–882. https://doi.org/10.1126/science.abm0475

Cascini, F., Pantovic, A., Al-Ajlouni, Y., Failla, G., Ricciardi, W., 2021. Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review. EClinicalMedicine 40, 101113. https://doi.org/10.1016/j.eclinm.2021.101113

Chevallier, C., Hacquin, A.-S., Mercier, H., 2021. COVID-19 Vaccine Hesitancy: Shortening the Last Mile. Trends Cogn. Sci. 25, 331–333. https://doi.org/10.1016/j.tics.2021.02.002

Dai, H., Saccardo, S., Han, M.A., Roh, L., Raja, N., Vangala, S., Modi, H., Pandya, S., Sloyan, M., Croymans, D.M., 2021. Behavioural nudges increase COVID-19 vaccinations. Nature 597, 404–409. https://doi.org/10.1038/s41586-021-03843-2

Daly, M., Robinson, E., 2021. Willingness to Vaccinate Against COVID-19 in the U.S.: Representative Longitudinal Evidence From April to October 2020. Am. J. Prev. Med. 60, 766–773. https://doi.org/10.1016/j.amepre.2021.01.008
Davis, C.J., Golding, M., McKay, R., 2021. Efficacy information influences intention to take COVID-19 vaccine. Br. J. Health Psychol. bjhp.12546. https://doi.org/10.1111/bjhp.12546
de Figueiredo, A., Simas, C., Karafillakis, E., Paterson, P., Larson, H.J., 2020. Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. The Lancet 396, 898–908. https://doi.org/10.1016/S0140-6736(20)31558-0
de Quidt, J., Vesterlund, L., Wilson, A.J., 2019. Experimenter demand effects, in: Schram, A., Aljaž, U. (Eds.), Handbook of Research Methods and Applications in Experimental Economics., Handbooks of Research Methods and Applications. Edward Elgar Publishing, UK, pp. 384–400.
Desson, Z., Kauer, L., Otten, T., Peters, J.W., Paolucci, F., 2021. Finding the way forward: COVID-19 vaccination progress in Germany, Austria and Switzerland. Health Policy Technol. 100584. https://doi.org/10.1016/j.hlpt.2021.100584
Desson, Z., Lambertz, L., Peters, J.W., Falkenbach, M., Kauer, L., 2020. Europe's Covid-19 outliers: German, Austrian and Swiss policy responses during the early stages of the 2020 pandemic. Health Policy Technol. 9, 405–418. https://doi.org/10.1016/j.hlpt.2020.09.003
Destatis, 2011. Zensus 2011. Statistische Ämter des Bundes und der Länder.
Dubé, E., Gagnon, D., MacDonald, N.E., 2015a. Strategies intended to address vaccine hesitancy: Review of published reviews. Vaccine 33, 4191–4203. https://doi.org/10.1016/j.vaccine.2015.04.041
Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., Bettinger, J.A., 2013. Vaccine hesitancy: An overview. Hum. Vaccines Immunother. 9, 1763–1773. https://doi.org/10.4161/hv.24657
Dubé, E., Vivion, M., MacDonald, N.E., 2015b. Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: influence, impact and implications. Expert Rev. Vaccines 14, 99–117. https://doi.org/10.1586/14760584.2015.964212
Dubé, È., Ward, J.K., Verger, P., MacDonald, N.E., 2021. Vaccine Hesitancy, Acceptance, and Anti-Vaccination: Trends and Future Prospects for Public Health. Annu. Rev. Public Health 42, 175–191. https://doi.org/10.1146/annurev-publhealth-090419-102240
Edwards, B., Biddle, N., Gray, M., Sollis, K., 2021. COVID-19 vaccine hesitancy and resistance: Correlates in a nationally representative longitudinal survey of the Australian population. PLOS ONE 16, e0248892. https://doi.org/10.1371/journal.pone.0248892
Eshun-Wilson, I., Mody, A., Tram, K.H., Bradley, C., Sheve, A., Fox, B., Thompson, V., Geng, E.H., 2021. Preferences for COVID-19 vaccine distribution strategies in the US: A discrete choice survey. PLOS ONE 16, e0256394. https://doi.org/10.1371/journal.pone.0256394
Eydlin, A., dpa, AFP, 2021. Coronavirus: Expertenrat empfiehlt rasche Kontaktbeschränkungen. Zeit.
Falagas, M.E., Zarkadoulia, E., 2008. Factors associated with suboptimal compliance to vaccinations in children in developed countries: a systematic review. Curr. Med. Res. Opin. 24, 1719–1741. https://doi.org/10.1185/03007990802085692
Federal Ministry of Health, n.d. Germany's information platform on the coronavirus [WWW Document]. URL https://www.zusammengegencorona.de/en/?articlefilter=all (accessed 11.24.21).
Fournet, N., Mollema, L., Ruijs, W.L., Harmsen, I.A., Keck, F., Durand, J.Y., Cunha, M.P., Wamsiedel, M., Reis, R., French, J., Smit, E.G., Kitching, A., van Steenbergen, J.E., 2018. Under-vaccinated groups in Europe and their beliefs, attitudes and reasons for non-vaccination; two systematic reviews. BMC Public Health 18, 196. https://doi.org/10.1186/s12889-018-5103-8
Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S.J., Tunis, M.C., Young, K., Hardy, K., Featherstone, R., Hartling, L., 2021. A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine 39, 222–236. https://doi.org/10.1016/j.vaccine.2020.10.038
German Federal Government, n.d. Corona-Impfung: Irrtümer und Falschinformationen [WWW Document]. Bundesregierung. URL https://www.bundesregierung.de/breg-de/themen/corona-informationen-impfung/mythen-impfstoff-1831898 (accessed 11.25.21).
Gerretsen, P., Kim, J., Caravaggio, F., Quilty, L., Sanches, M., Wells, S., Brown, E.E., Agic, B., Pollock, B.G., Graff-Guerrero, A., 2021. Individual determinants of COVID-19 vaccine hesitancy. PLOS ONE 16, e0258462. https://doi.org/10.1371/journal.pone.0258462
Ghanem, D., Hirshleifer, S., Ortiz-Becerra, K., 2021. Testing Attrition Bias in Field Experiments. https://doi.org/10.26085/C38C76
Graeber, D., Schmidt-Petri, C., Schröder, C., 2021. Attitudes on voluntary and mandatory vaccination against COVID-19: Evidence from Germany. PLOS ONE 16, e0248372. https://doi.org/10.1371/journal.pone.0248372
James, E.K., Bokemper, S.E., Gerber, A.S., Omer, S.B., Huber, G.A., 2021. Persuasive messaging to increase COVID-19 vaccine uptake intentions. Vaccine 39, 7158–7165. https://doi.org/10.1016/j.vaccine.2021.10.039
Kachurka, R., Krawczyk, M., Rachubik, J., 2021. Persuasive Messages Will Not Increase COVID-19 Vaccine Acceptance: Evidence from a Nationwide Online Experiment. Vaccines 9, 1113. https://doi.org/10.3390/vaccines9101113
Kerr, J.R., Freeman, A.L.J., Marteau, T.M., van der Linden, S., 2021. Effect of Information about COVID-19 Vaccine Effectiveness and Side Effects on Behavioural Intentions: Two Online Experiments. Vaccines 9, 379. https://doi.org/10.3390/vaccines9040379

Larson, H.J., Jarrett, C., Eckersberger, E., Smith, D.M.D., Paterson, P., 2014. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. Vaccine 32, 2150–2159. https://doi.org/10.1016/j.vaccine.2014.01.081

Lazarus, J.V., Ratzan, S.C., Palayew, A., Gostin, L.O., Larson, H.J., Rabin, K., Kimball, S., El-Mohandes, A., 2021. A global survey of potential acceptance of a COVID-19 vaccine. Nat. Med. 27, 225–228. https://doi.org/10.1038/s41591-020-1124-9

Leiner, D.J., 2021. SoSci Survey.

Lindholt, M.F., Jørgensen, F., Bor, A., Petersen, M.B., 2021. Public acceptance of COVID-19 vaccines: cross-national evidence on levels and individual-level predictors using observational data. BMJ Open 11, e048172. https://doi.org/10.1136/bmjopen-2020-048172

Loomba, S., de Figueiredo, A., Piatek, S.J., de Graaf, K., Larson, H.J., 2021. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nat. Hum. Behav. 5, 337–348. https://doi.org/10.1038/s41562-021-01056-1

MacDonald, N.E., 2015. Vaccine hesitancy: Definition, scope and determinants. Vaccine 33, 4161–4164. https://doi.org/10.1016/j.vaccine.2015.04.036

Mathieu, E., Ritchie, H., Ortiz-Ospina, E., Roser, M., Hasell, J., Appel, C., Giattino, C., Rodés-Guirao, L., 2021. A global database of COVID-19 vaccinations. Nat. Hum. Behav. 5, 947–953. https://doi.org/10.1038/s41562-021-01122-8

McIntosh, E.D.G., Janda, J., Ehrich, J.H.H., Pettoello-Mantovani, M., Somekh, E., 2016. Vaccine Hesitancy and Refusal. J. Pediatr. 175, 248-249.e1. https://doi.org/10.1016/j.jpeds.2016.06.006

Mottelson, A., Vandeweerdt, C., Atchapero, M., Luong, T., Holz, C., Böhm, R., Makransky, G., 2021. A self-administered virtual reality intervention increases COVID-19 vaccination intention. Vaccine 39, 6746–6753. https://doi.org/10.1016/j.vaccine.2021.10.004

Murphy, J., Vallières, F., Bentall, R.P., Shevlin, M., McBride, O., Hartman, T.K., McKay, R., Bennett, K., Mason, L., Gibson-Miller, J., Levita, L., Martinez, A.P., Stocks, T.V.A., Karatzias, T., Hyland, P., 2021. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. Nat. Commun. 12, 29. https://doi.org/10.1038/s41467-020-20226-9

Naaber, P., Tserel, L., Kangro, K., Sepp, E., Jürjenson, V., Adamson, A., Haljasmägi, L., Rumm, A.P., Maruste, R., Kärner, J., Gerhold, J.M., Planken, A., Ustav, M., Kisand, K., Peterson, P., 2021. Dynamics of antibody response to BNT162b2 vaccine after six months: a longitudinal prospective study. Lancet Reg. Health - Eur. 10, 100208. https://doi.org/10.1016/j.lanepe.2021.100208

Neumann-Böhme, S., Varghese, N.E., Sabat, I., Barros, P.P., Brouwer, W., van Exel, J., Schreyögg, J., Stargardt, T., 2020. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. Eur. J. Health Econ. 21, 977–982. https://doi.org/10.1007/s10198-020-01208-6

Niehues, J., Stockhausen, M., 2019. Einkommensverteilung nach sozioökonomischen Teilgruppen. Niehues IW-Kurzber.

Nordström, P., Ballin, M., Nordström, A., 2021. Effectiveness of Covid-19 vaccination against risk of symptomatic infection, hospitalization, and death up to 9 months: a Swedish total-population cohort study. Prepring Lancet 9.

Omer, S.B., Betsch, C., Leask, J., 2019. Mandate vaccination with care. Nature 571, 469–472. https://doi.org/10.1038/d41586-019-02232-0

OpenStreetMap contributors, 2017. Planet dump.

Paul, K.T., Zimmermann, B.M., Corsico, P., Fiske, A., Geiger, S., Johnson, S., Kuiper, J.M.L., Lievevrouw, E., Marelli, L., Prainsack, B., Spahl, W., Van Hoyweghen, I., 2022. Anticipating hopes, fears and expectations towards COVID-19 vaccines: A qualitative interview study in seven European countries. SSM - Qual. Res. Health 2, 100035. https://doi.org/10.1016/j.ssmqr.2021.100035

Paules, C.I., Marston, H.D., Fauci, A.S., 2019. Measles in 2019 — Going Backward. N. Engl. J. Med. 380, 2185–2187. https://doi.org/10.1056/NEJMp1905099

Petersen, M.B., Bor, A., Jørgensen, F., Lindholt, M.F., 2021. Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. Proc. Natl. Acad. Sci. 118. https://doi.org/10.1073/pnas.2024597118

Pfattheicher, S., Petersen, M.B., Böhm, R., 2021. Information about herd immunity through vaccination and empathy promote COVID-19 vaccination intentions. Health Psychol. https://doi.org/10.1037/hea0001096

Poethko-Müller, C., Ellert, U., Kuhnert, R., Neuhauser, H., Schlaud, M., Schenk, L., 2009. Vaccination coverage against measles in German-born and foreign-born children and identification of unvaccinated subgroups in Germany. Vaccine 27, 2563–2569. https://doi.org/10.1016/j.vaccine.2009.02.009

Rabb, N., Glick, D., Houston, A., Bowers, J., Yokum, D., 2021. No evidence that collective-good appeals best promote COVID-related health behaviors. Proc. Natl. Acad. Sci. 118, e2100662118. https://doi.org/10.1073/pnas.2100662118

Rainey, J.J., Watkins, M., Ryman, T.K., Sandhu, P., Bo, A., Banerjee, K., 2011. Reasons related to non-vaccination and under-vaccination of children in low and middle income countries: Findings from a systematic review of the published literature, 1999–2009. Vaccine 29, 8215–8221. https://doi.org/10.1016/j.vaccine.2011.08.096

Rehmet, S., Ammon, A., Pfaff, G., Bocter, N., Petersen, L.R., 2002. Cross-Sectional Study on Influenza Vaccination, Germany, 1999–2000. Emerg. Infect. Dis. 8, 1442–1447. https://doi.org/10.3201/eid0812.010497

RKI, 2021a. Coronavirus Disease 2019 - Daily Situation Report 20/12/2021 (No. 20/12/2021), Current State for Germany. Robert Koch Institute.

RKI, 2021b. Coronavirus Disease 2019 - Daily Situation Report 19/10/2021 (No. 19/10/2021), Current State for Germany. Robert Koch Institute.

Ruiz, J.B., Bell, R.A., 2021. Predictors of intention to vaccinate against COVID-19: Results of a nationwide survey. Vaccine 39, 1080–1086. https://doi.org/10.1016/j.vaccine.2021.01.010

Schmid, P., Rauber, D., Betsch, C., Lidolt, G., Denker, M.-L., 2017. Barriers of Influenza Vaccination Intention and Behavior – A Systematic Review of Influenza Vaccine Hesitancy, 2005 – 2016. PLOS ONE 12, e0170550. https://doi.org/10.1371/journal.pone.0170550

Schwarzinger, M., Watson, V., Arwidson, P., Alla, F., Luchini, S., 2021. COVID-19 vaccine hesitancy in a representative working-age population in France: a survey experiment based on vaccine characteristics. Lancet Public Health 6, e210–e221. https://doi.org/10.1016/S2468-2667(21)00012-8

Solís Arce, J.S., Warren, S.S., Meriggi, N.F., Scacco, A., McMurry, N., Voors, M., Syunyaev, G., Malik, A.A., Aboutajdine, S., Adeojo, O., Anigo, D., Armand, A., Asad, S., Atyera, M., Augsburg, B., Awasthi, M., Ayesiga, G.E., Bancalari, A., Björkman Nyqvist, M., Borisova, E., Bosancianu, C.M., Cabra García, M.R., Cheema, A., Collins, E., Cuccaro, F., Farooqi, A.Z., Fatima, T., Fracchia, M., Galindo Soria, M.L., Guariso, A., Hasanain, A., Jaramillo, S., Kallon, S., Kamwesigye, A., Kharel, A., Kreps, S., Levine, M., Littman, R., Malik, M., Manirabaruta, G., Mfura, J.L.H., Momoh, F., Mucauque, A., Mussa, I., Nsabimana, J.A., Obara, I., Otálora, M.J., Ouédraogo, B.W., Pare, T.B., Platas, M.R., Polanco, L., Qureshi, J.A., Raheem, M., Ramakrishna, V., Rendrá, I., Shah, T., Shaked, S.E., Shapiro, J.N., Svensson, J., Tariq, A., Tchibozo, A.M., Tiwana, H.A., Trivedi, B., Vernot, C., Vicente, P.C., Weissinger, L.B., Zafar, B., Zhang, B., Karlan, D., Callen, M., Teachout, M., Humphreys, M., Mobarak, A.M., Omer, S.B., 2021. COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries. Nat. Med. 27, 1385–1394. https://doi.org/10.1038/s41591-021-01454-y

Sprengholz, P., Betsch, C., Böhm, R., 2021. Reactance revisited: Consequences of mandatory and scarce vaccination in the case of COVID-19. Appl. Psychol. Health Well-Being 13, 986–995. https://doi.org/10.1111/aphw.12285

Strategic Advisory Group of Experts on Immunization, 2014. Report of the SAGE working group on vaccine hesitancy. World Health Organization.

Thaker, J., Subramanian, A., 2021. Exposure to COVID-19 Vaccine Hesitancy Is as Impactful as Vaccine Misinformation in Inducing a Decline in Vaccination Intentions in New Zealand: Results from Pre-Post Between-Groups Randomized Block Experiment. Front. Commun. 6, 159. https://doi.org/10.3389/fcomm.2021.721982

Thunström, L., Ashworth, M., Finnoff, D., Newbold, S.C., 2021. Hesitancy Toward a COVID-19 Vaccine. EcoHealth 18, 44–60. https://doi.org/10.1007/s10393-021-01524-0

Troiano, G., Nardi, A., 2021. Vaccine hesitancy in the era of COVID-19. Public Health 194, 245–251. https://doi.org/10.1016/j.puhe.2021.02.025

Umakanthan, S., Lawrence, S., 2022. Predictors of COVID-19 vaccine hesitancy in Germany: a cross-sectional, population-based study. Postgrad. Med. J. postgradmedj-2021-141365. https://doi.org/10.1136/postgradmedj-2021-141365

Williams, S.E., 2014. What are the factors that contribute to parental vaccine-hesitancy and what can we do about it? Hum. Vaccines Immunother. 10, 2584–2596. https://doi.org/10.4161/hv.28596

Wismans, A., Thurik, R., Baptista, R., Dejardin, M., Janssen, F., Franken, I., 2021. Psychological characteristics and the mediating role of the 5C Model in explaining students' COVID-19 vaccination intention. PLOS ONE 16, e0255382. https://doi.org/10.1371/journal.pone.0255382

Wolfe, R.M., Sharp, L.K., 2002. Anti-vaccinationists past and present 325, 3.

World Medical Association, 2013. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA 310, 2191–2194. https://doi.org/10.1001/jama.2013.281053

Zizzo, D.J., 2010. Experimenter demand effects in economic experiments. Exp. Econ. 13, 75–98. https://doi.org/10.1007/s10683-009-9230-z

5 *Transformation to organic agriculture is not constrained by ideological barriers: Evidence from German farmers*

Matthias Mayer, Maximilian N. Burger, Björn Vollan[1†]

Abstract:

Agriculture plays an important role in Germany's goal of becoming climate neutral by 2050. An important pillar for achieving this goal is to increase the share of organic farming. We conducted 110 online surveys with farmers to explore whether farmers are prone to engage in confirmation bias when confronted with information that challenges their farming practices. While we find evidence of confirmation bias both among conventional and organic farmers, organic farmers seem to be much more ideologically polarized than conventional farmers. Furthermore, we carried out 821 online surveys with respondents from the general public and asked them to predict how farmers answered our questions. In contrast to public expectations, farmers in our sample are far less polarized and conventional farmers, in particular, are much more open-minded and concerned about the environment than the public expects. Our results suggest that farmers are strongly misperceived by the public and that a sustainable transformation of agriculture in Germany is not hindered by confirmation bias.

Keywords: Motivated reasoning, sea-level rise risks, multiple country evidence

[1] Authors affiliation: School of Economics and Business, Universität Marburg, Germany
[†] Correspondence: Björn Vollan, bjoern.vollan@wiwi.uni-marburg.de

Acknowledgments: We thank Stefan Hotes, Chuo University, for valuable feedback on the survey design and for connecting us with Heike Wagner from Landkreis Marburg-Biedenkopf who allowed us to contact local farmers via e-mail. We are thankful to all respondents who took the time to participate.

Funding: This work was supported by the Research Campus of Central Hesse (RCCH) for funding the project (Flexi-Funds 1/2017). Authors declare no competing interests.

Ethics statement: The study design and field implementation were designed and conducted according to the World Medical Association Declaration of Helsinki (2013). All respondents gave their informed consent and were free to resign from the study at any time. Respondents were compensated between 4 and 18 Euros for completing the survey. Respondents in the general population survey received 0.75 euros.

Data and materials availability: The surveys, data, and analysis files will be made available after publication.

5.1 Introduction

Germany has set itself the goal of becoming climate neutral by 2050, if not sooner. Agriculture, which is responsible for 8.2% of total greenhouse gas emissions, plays a crucial role in achieving this sustainable transformation (German Environment Agency, 2021). According to the official road map, 20% of agricultural land is to be farmed organically by 2030 (German Federal Government, 2016). As of 2020, however, less than 10% is farmed organically (German Federal Government, 2020). The transition from existing conventional farms and farming practices to more sustainable agriculture faces many barriers and constitutes a deep lock-in with oftentimes large sunk costs in infrastructure and cultural conventions underpinning their practices. Farmers have made specific investments that have led to capital and land commitments, as well as infrastructural, organizational, and technological path dependencies as described in well-established transformation concepts (Loorbach et al., 2017). While some farmers state that they would be willing to adopt more sustainable practices (Bakker, 2021; Bartkowski and Bartke, 2018; Jantke et al., 2020) profit-seeking attitudes seem to be a key barrier to change (Dessart et al., 2019; Serebrennikov et al., 2020). In addition, for many farmers, especially smaller ones, farming is not just about making a profit; it is also part of their identity, values, and worldview. Consequently, stigmatizing conventional farming or imposing organic farming practices might be perceived as an intrusion and arguments in support of such a transformation could prompt identity-protective cognition (Kahan et al., 2007), provoking defiance, resistance, or reactance (Petty and Cacioppo, 1979). One form of this reasoning pattern is the confirmation bias (Nickerson, 1998). It is characterized by the targeted search for information as well as its interpretation in order to confirm and update pre-existing beliefs, attitudes, and values, and has been studied on a wide range of topics, for example, see Bénabou and Tirole (2016) and Golman et al. (2017). Therefore, to take urgent action on climate change (SDG 13), climate action must not only be integrated into national policies but also ensure that awareness and acceptance of these goals improve as well. Real or perceived stigmatization of farmers, as well as polarization between good and bad forms of agriculture, could hinder open, transformative dialogue and lead to abdication of responsibility.

From a policy perspective, we believe it is critical to recognize whether the reluctance of certain actors is mainly due to their inability or unwillingness. Because, if structural barriers, rather than farmers' unwillingness, prevent farmers from transforming their practices, policymakers need to understand how to embed information and incentives in a policy framework that depolarizes the societal debate and refrains from blaming actors who have been unable to transform. We conducted online surveys with 110 German farmers and 821 respondents reflecting the overall population given age and gender in

Germany (see supplementary materials D.2). We find a substantial willingness among farmers to adopt sustainable practices, with over 51% of non-certified organic farmers reporting that they would prefer having an organic farm if they could start over. Contrary to public opinion, farmers are much more environmentally aware and open to engaging with information that challenges the sustainability of their agricultural practices. Importantly, we measure farmers' confirmation bias by examining whether they ignore information that challenges their practices over information that confirms them. Contrary to public expectations, we find that conventional farmers are less likely than organic certified farmers to have confirmation bias (17% vs. 47%, T-Test diff. = -.30, $t_{110} = -2.703$, $p < .008$).

Our results further highlight that a binary distinction between organic and conventional farming practices ignores important differences among conventional farmers. Many of them already use organic practices but are not certified. A more precise classification could help policymakers target their regulations more accurately to promote sustainable agriculture. For example, by assisting farmers who are already in the process of converting but need support to do so. Our research contributes to the growing literature on farmers' motivation to adopt more sustainable practices increased in recent years (Bakker, 2021; Bartkowski and Bartke, 2018; Dessart et al., 2019; Jantke et al., 2020; Serebrennikov et al., 2020).

5.2 Methods

To measure public opinion, we conducted online surveys with 821 people from the German public, reflecting the overall population in terms of age and gender (see supplementary materials D.2.2). To investigate ideological barriers to conversion to organic farming, we interviewed 110 farmers in Hesse, Germany, via an online survey. While the sample of farmers is locally restricted the distribution of conventional and organic farms given farm sizes is nevertheless similar to the overall distribution in Germany (see supplementary materials D.2.1).

5.2.1 Farmers survey

In the farmer survey, we tested whether farmers are prone to engage in confirmation bias. In addition, we asked about the applied farming practices, ideological disposition toward organic and conventional farming, environmental awareness, as well as their willingness to invest time and money into more sustainable farming, and their willingness to convert towards organic farming.

Confirmation bias: We measure confirmation bias by asking respondents to rate two factually true but contradictory pieces of information based on peer-reviewed studies. One summarized studies indicating that conventional agriculture produces fewer greenhouse gas emissions, e.g., due to more efficient production and economies of scale, while the other set of information summarized studies concluding that organic agriculture produces fewer emissions, e.g., due to using less fertilizer (see supplementary materials D.7 for details). After reading both pieces of information, farmers were asked whether either or both pieces of information should be ignored in the current debate about climate change and sustainability in Germany. This set-up allows us to test whether farmers avoid information that might cause cognitive dissonance. We measured both the time spend on each information page as well as whether respondents clicked on a button to receive additional information.

Farming practice: Farming practice was measured on a self-stated continuous scale from 0 'fully organic practice' to 10 'fully conventional practice'. While many studies and public statistics use official certificates to distinguish between organic and conventional farmers, we asked respondents to classify themselves. The reason for this is twofold: First, some farmers chose not to apply for certification despite fully adhering to organic principles, as the process is time- and cost-intensive (Bartkowski and Bartke, 2018). In our sample, only 15 out of 29 farmers who classify themselves as completely organic have an official certificate. Second, while more than half of our sample focuses on one of the two extremes (see Fig. D.5 supplementary materials, N = 31, 28% fully organic, N = 29, 25% fully conventional), many farmers fall somewhere in between. Out of those who are not certified, 30% nevertheless report adhering mainly to organic farming practices, and only 52% of those who report only applying organic farming practices are certified. A binary classification on organic certificates would omit this variation in farming practices and prevent us from distinguishing between farmers who mainly employ organic practices (OP), yet are not certified, and farmers who mainly employ conventional practices (CP). Going forward, we use this self-classification to derive a conservative measure for the support of a sustainability transformation in agriculture among the self-classified conventional farmers in our sample (such as in Table 5.1).

Farming ideology: Farming ideology was measured in two steps: First, we asked farmers how much they agree or disagree with eleven polarizing statements, for example, 'Conventional agriculture is better suited to ensure food security' and 'Grazing is indispensable for species-appropriate cattle farming' ($\alpha = .820$). Based on their answers we ranked them on a scale from 0 fully 'organic ideology' (OI) to 10 fully 'conventional ideology' (CI). Respondents were then asked to adjust the resulting score in case they felt misrepresented (see supplementary materials Fig. D.7A for the adjustments made).

Environmental awareness: To assess environmental awareness we adopted a validated scale from Montada et al. (2014a), that takes the average over seven items, resulting in a scale ranging from 1 to 6 (α = .734). Again, we asked respondents to adjust their final score to ensure accuracy, which yielded some but not systematic changes in the final score (see Fig. D.7B).

Willingness to invest: We derived a measure of farmers' willingness to invest time and money in improving the environmental sustainability of their farms by applying principal component analysis to a modified questionnaire battery from (Montada et al., 2014b) adapted to our study (α = .855, kmo = .753).

Openness to change: Farmers' openness to change their current farming practice was measured by asking respondents what type of farm they would choose (conventional or organic) if they had the option to start a new farm. To obtain unconstrained, i.e., pure, preferences this question deliberately abstracts from financial limitations, potential sunk-cost effects of previous investments, and other factors that might keep farmers locked into their current conventional farming practice.

Table 5.1 Summary statistics: Farmer sample

	(1) Organic Farmers Mean/SD	(2) Conventional Farmers Mean/SD	(3) Pooled Mean/SD
Dependent variables			
Ignore organic information (=1)	0.13	0.18	0.15
	[0.33]	[0.39]	[0.36]
Ignore conventional information (=1)	0.29	0.10	0.18
	[0.46]	[0.30]	[0.39]
Main explanatory variable			
Ideology (0 org. – 10 con.)	7.70	4.25	5.75
	[2.19]	[2.73]	[3.03]
Farmer mindset			
Profit orientation (0 – 10)	2.79	4.42	3.71
	[2.02]	[1.95]	[2.13]
Environmental awareness (0-10)	8.57	7.65	8.05
	[1.27]	[1.33]	[1.38]
Willingness to seek information (1-6)	4.76	4.74	4.75
	[1.15]	[1.04]	[1.09]
Sustainability over profit (1-6)	5.04	3.94	4.42
	[1.01]	[1.40]	[1.36]
Start-over as organic	0.81	0.37	0.56
	[0.39]	[0.49]	[0.50]
Farm characteristics			
Farming practice (0 org. – 10 con.)	8.72	1.31	4.55
	[1.87]	[1.48]	[4.04]
Farm size (ln)	2.89	3.53	3.25
	[1.13]	[1.16]	[1.19]
Livestock (=1)	0.40	0.42	0.41
	[0.49]	[0.50]	[0.49]
Fulltime farmer (=1)	0.19	0.34	0.27
	[0.39]	[0.48]	[0.45]
Observations	48	62	110

Notes: Table 5.1 shows mean, SD, minimum and maximum values of outcome, explanatory, and control variables. The columns differ by self-reported agricultural practices. Column 1 shows farmers who reported

using mostly organic practices, column 2 shows farmers who reported using mostly conventional practices, and column 3 shows the pooled results for all respondents. More details on sample characteristics are provided in D.1.

5.2.2 General population survey

Respondents were recruited from a general population panel in Germany by the survey company Respondi in September 2021. We asked respondents to rate how they think conventional and organic farmers answered questions in the farmers' survey. To measure the extent to which the public expects farmers to commit confirmation bias, we asked respondents to estimate the percentage of farmers who ignore information that calls their farming practices into question. The perception of farmers' *environmental awareness* was measured by having respondents answer the same items adopted from Montada et al. (2014a) and allowing them to correct their resulting scale. Finally, we asked respondents to estimate how conventional and organic farmers ranked on the same scale. The perception of farmers' *willingness to invest* time and money into marking their farms more environmentally friendly was measured by reframing the questions we asked farmers. For example, while we asked farmers how willing they are to seek out information about current environmental issues in agriculture, we asked respondents from the general public whether conventional or organic farmers are generally willing to seek out information about current environmental issues in agriculture. Finally, to measure conventional farmers' perceived *openness to change*, respondents were asked what type of farm (conventional or organic) conventional farmers would choose if they could start over.

5.3 Results

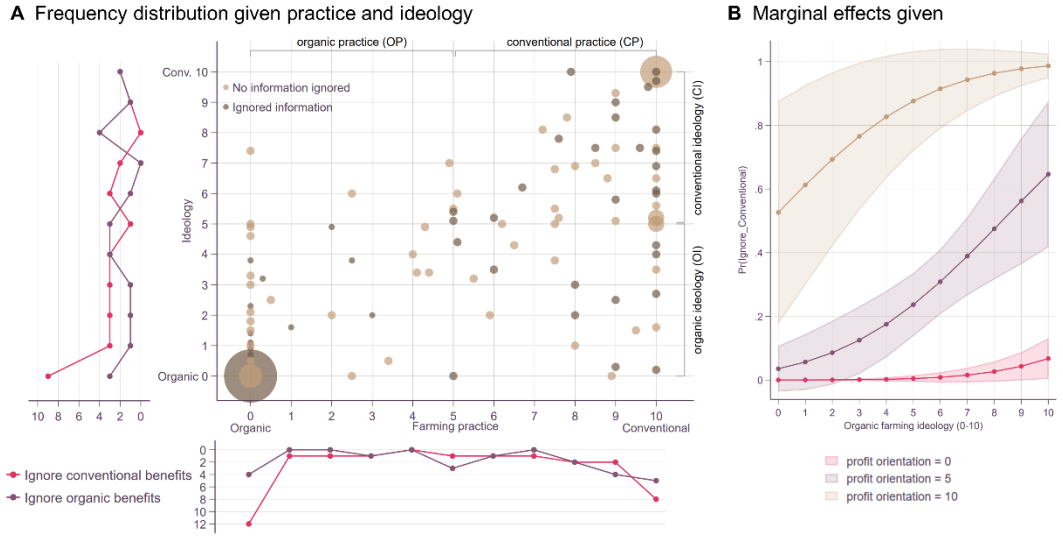
The results section is organized as follows: First, we present the results on farmers' confirmation bias. Second, we compare public opinion with the results of the farmers' survey.

5.3.1 Confirmation bias

Farmers who reported predominantly using conventional practices and farmers who reported predominantly using organic practices spent an equal amount of time on both information pages (pro-organic page: D = .127, p = .788; pro-conventional: page D = .178, p = .370) and were equally likely to look at the optional additional information (pro-organic page coefficient: ß = .084, p = .307, 95%CI: -.78 to .25; pro-conventional page coefficient: ß = -.089, p = .285, 95%CI: -.25 to .075; see supplementary materials D.1). Overall, 45% (50 of 110) of all farmers indicated that either of the information should be ignored, with 18% (20 of 110) indicating that the organic information should be ignored and 27% (30 of 110) indicating that the conventional information should be ignored. As

shown in Fig.5.1A, ignoring information cannot be attributed to only one group of farmers. Farmers who reported applying purely conventional farming practices are neither more likely to ignore information in general, $\chi2(1, N = 110) = .014$, $p = .905$, nor are they more likely to ignore information that emphasizes the sustainable benefits of organic agriculture, $\chi2(1, N = 110) = .003$, $p = .959$. In contrast, farmers that reported only using organic farming practices were more likely to state that the information highlighting sustainable benefits of conventional farming should be ignored, $\chi2(1, N = 110) = 3.369$, $p = .066$, especially farmers with organic certification, $\chi2(1, N = 110) = 5.947$, $p = .002$.

Fig. 5.1 Ignoring information given agricultural practices and ideology



Notes Panel A shows farming practices and ideologies reported by farmers. Farmers who indicated that one of the information should be ignored are indicated by the dark circles. The frequency distribution of ignoring information about organic or conventional farming is shown on the left given the farming ideology and below given the farming practices. Panel B shows the prediction margins with 95% confidence intervals of ideology at low, medium, and high profit orientation. The confidence intervals are indicated by the shaded area for each profit orientation group.

To determine whether farmers are engaging in confirmation bias, we examine whether farmers are more likely to ignore information about conventional or organic agriculture because of their farming ideology, i.e., their pre-existing beliefs on agriculture. The marginal effects of the probit-regression are reported in Table 5.2. Contrary to our expectation, ideology does not predict the likelihood of ignoring organic information (column 1). Furthermore, none of the variables describing farm characteristics or farmers' attitudes had a significant effect on the likelihood of ignoring the information on organic farming. However, agricultural ideology plays a statistically significant role in the likelihood of ignoring conventional information (column 2). A one-step increase in ideology toward organic is associated with a 5% increase in the likelihood of ignoring information that emphasizes the sustainable benefits of conventional agriculture. In addition, a one-step increase in farmers' profit orientation increases the likelihood of ignoring the conventional information by 9%. Fig. 5.1B shows the estimated probability to

ignore the information about conventional agriculture given the ideology and profit orientation. The figure shows that the confirmation bias, in this case ignoring the information opposing one's ideology, is especially strong among farmers with a strong organic ideology and a high profit orientation.

Table 5.2 Determinants of the suggestion to ignore information

VARIABLES	(1) Ignore organic (=1)	(2) Ignore conventional (=1)
Ideology (0 Conventional – 10 Organic)	-0.01	0.05***
	(0.01)	(0.02)
Farmer mindset		
Profit orientation (0 – 10)	-0.01	0.09***
	(0.02)	(0.02)
Environmental awareness (0-10)	0.01	0.03
	(0.03)	(0.03)
Willingness to seek information (1-6)	-0.01	0.02
	(0.03)	(0.04)
Sustainability over profit (1-6)	-0.01	0.04
	(0.04)	(0.03)
Farm characteristics		
Farm size (ln)	0.01	-0.06**
	(0.03)	(0.03)
Livestock (=1)	0.04	0.11
	(0.07)	(0.07)
Fulltime farmer (=1)	-0.03	0.02
	(0.07)	(0.06)
Socioeconomics	yes	yes
Observations	110	110
Pseudo R-squared	0.10	0.33

Notes: The binary dependent variable indicates whether respondents stated that the information that highlights the sustainable benefits of organic farming (column 1) or conventional farming (column 2) should be ignored. Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The complete regression table is reported in supplementary Table D.4.

We test the robustness of our results against several different specifications, for example, comparing only respondents who ignore a piece of information to respondents who ignore no information. The results obtained under these alternative analyses do not substantially differ from those of the main analysis. As the effect found of ideology and profit orientation on the ignoring decision in these robustness tests is either greater or equal to that in the main analysis, we consider the results of our main analysis as a conservative estimate (robustness checks are presented in D.4 for the interested reader).

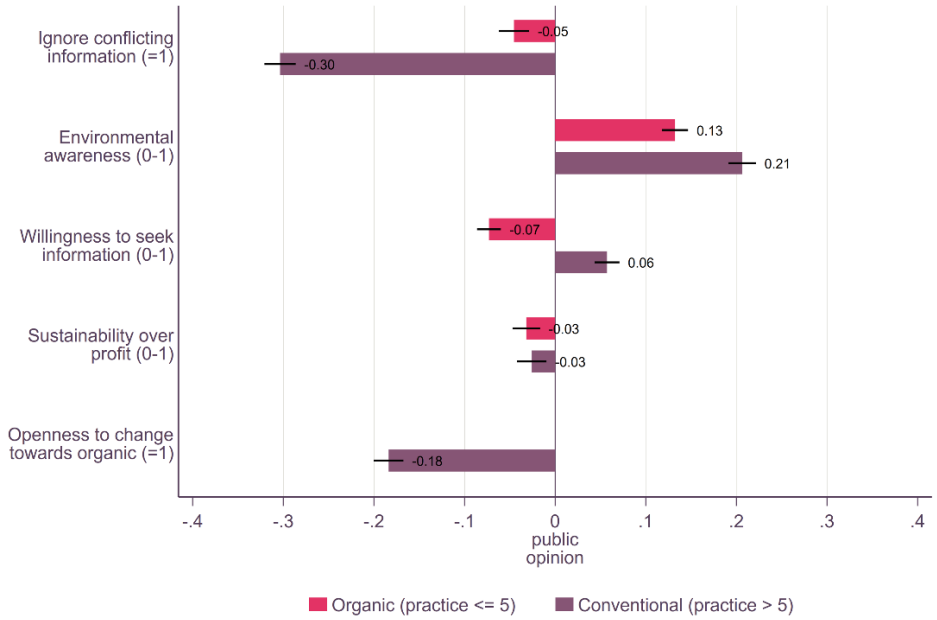
In summary, we find confirmation bias among both conventional and organic farmers. However, we only find a correlation between farmers holding an organic ideology and ignoring information emphasizing the sustainable benefits of conventional farming, but not between farmers holding a conventional ideology and ignoring information about organic farming. Moreover, this relationship between organic ideology and ignoring information

about conventional farming seems to be particularly pronounced among farmers with a high profit orientation.

5.3.2 Misperception of farmers in the general public

In this section, we analyze the perception of farmers in the German public. We asked respondents in the general population survey how they believe organic certified and non-certified conventional farmers answered the questionnaire. Thus, in this section, we distinguish farmers based on whether they are officially certified organic farmers or not. In contrast, in the previous section, we distinguished farmers based on their self-stated farming practices and their farming ideology. In D.5 supplementary materials, we show the results using self-reported farming practices as the delineator between organic and conventional farmers.

Fig. 5.2 Deviation of farmers' responses from public opinion



Note: The deviations of the farmers' responses from the public's expectations are indicated by the bars. Public expectations, i.e., the average response in the general population survey, corresponds to the number "0" on the x-axis. Bars deviating to the left indicate that farmers' responses are below public expectations. Bars deviating to the right indicate that farmers' responses exceeded public expectations. The 95% confidence intervals are indicated by the lines.

Fig. 5.2 shows the deviation of farmers' responses compared to public expectations, that is the average answers provided in the general population survey. The public significantly underestimates the proportion of certified organic farmers who ignore information about the sustainable benefits of conventional farming (38% vs. 53%, T-Test diff. = .15, $t_{836} = 2.354$, $p < .019$) and significantly overestimates the proportion of non-certified conventional farmers who ignore information about organic farming (51% vs. 22%, T-Test diff. = -.29, $t_{916} = 9.872$, $p < .001$). In addition, environmental awareness is underestimated for both certified and non-certified farmers (0.64 vs. 0.81, T-Test diff. = .16, $t_{1,752} = 7.335$,

$p < .001$), but especially for non-certified farmers (0.56 vs. 0.80, T-Test diff. = .24, $t_{916} = 10.341$, $p < .001$). Non-certified farmers are also significantly more likely to report that they are willing to seek information about improving the sustainability of their farming practices (0.67 vs. 0.62, T-Test diff. = .05, $t_{916} = 2.375$, $p < .018$) than the public expects them to do. To our surprise, respondents in the general population believed that 55% of non-certified farmers would prefer to change to certified organic farming. This is pretty much in line with the responses we received in the farmer survey: 51% of non-certified farmers and over 76% of non-certified farmers who already use mostly organic farming practices reported that they would switch to organic farming if they could.

In summary, the general public considers farmers to be much more polarized than what is found in our study. Conventional farmers, in particular, are much more open to information questioning the sustainability of their farming practices than the public expects. In addition, both organic and conventional farmers are much more environmentally conscious than the public believes.

5.4 Discussion

In our sample, over 30% of non-certified farmers report that they use primarily organic farming practices. Out of those who report only using organic practices, only 52% are certified as such. In addition, 51% of non-certified farmers stated that they would prefer to start an organic farm if they could start over. To better illustrate the potential for converting farmland from conventional to organic in Hesse, Germany, we employ a rough back-of-the-envelope calculation (see supplementary materials D.6.2). If all farmers had the opportunity to convert to organic farming, the size of organically cultivated land could increase by 420% from 2,272k to 9,542k ha. While this prediction is of course not to be taken literally, these figures nevertheless illustrate that achieving climate neutrality is not obstructed by farmers' supposedly unwillingness to change. Quite to the contrary, farmers seem to support a sustainable transformation of agriculture. It seems that policymakers so far failed to take advantage of this demand for sustainable change. This might also explain why 18% of farmers stated that their interests are not represented by any political party in Germany (see supplementary Fig. D.6). We speculate that policymakers have a similarly distorted view of farmers as the public seems to have. One reason for this misperception of farmers might be their one-sided representation in public. For example, the German Farmers' Association (DBV) is the largest and most vocal advocacy group claiming to represent the interests of all German farmers. However, an investigation by the Nature And Biodiversity Conservation Union (NABU, 2019) has revealed the close links between the Farmers' Association, agricultural policy, and the agricultural industry. The report argues that the association has spent years lobbying for policies that are not in the best

interest of farmers, especially not small farmers. This prompted protests by the organization "Wir haben es satt!" (We've had it!), which calls for an agricultural transformation and accuses the Farmers' Association of pursuing the wrong objectives (Deter, 2013). In our sample, only 27% reported to part of any agricultural association, and less than 15% stated to be a member of the German Farmers' Association (DBV).

There are three main limitations of our study that we would like to address. First, our sample is quite small and comes from a specific area in Germany. While the distribution in terms of farm sizes and the proportion of organically certified land in the sample corresponds to the distribution in Hesse and Germany as a whole (see supplementary materials D.2.1), we cannot verify whether it differs systematically in other aspects. Second, we are unable to detect factors determining the suggestion to ignore information highlighting the benefits of organic agriculture. Testing for differences in the interaction with the information sets suggests that this is not due to disinterest in the organic datasets per se as those with an organic ideology do not differ from those with a conventional ideology in terms of time spent on each information page or probability of clicking more details regarding either information (see D.3.4). Third, since our study is based on survey data we have to rely on many self-reported measures. It has been argued that respondents may behave differently once cues about appropriate behavior have been provided by the experimenter, i.e. experimenter demand effect (Zizzo, 2010). In our case, respondents may have assumed that we deem organic farming as the more desirable farming practice and therefore stated to be more organic than they are. Furthermore, if respondents had the impression the study aimed to stigmatize conventional farmers they may have untruly reported their farming practice or exaggerated their openness to conflicting information (de Quidt et al., 2019). Lastly, general population data is from an opt-in online panel provided by Respondi. While it seems representative of the German population in terms of age and gender, this might not necessarily be the case for people's perception of German farmers.

5.5 Conclusion

We find strong discrepancies between public expectations and farmers' responses. While 51% in the general population survey expected conventional farmers to commit confirmation bias, that is, to ignore information that stands in conflict with their farming practices, only 22% do. In contrast, 53% of organic farmers tend to engage in confirmation bias, although only 38% of the public expected them to do so. Overall, the public seems to regard farmers as much more polarized and less concerned about the environment than we find in our study.

Furthermore, our results suggest that Germany's self-declared goal of farming 20% of its agricultural land organically by 2030 is not obstructed by farmers' unwillingness to change. On the contrary, 15% (14 out of 95) of conventional farmers report that they already farm fully organically but are not certified as such, and a further 23% (19 out of 62) report using mostly organic methods. In total, 37% (23 of 39) of conventional farmers in our sample say they would prefer an organic farm if they could start over again.

This raises two key questions that need to be answered in future research. First, what prevents farmers from converting to organic farming? If farmers want to adopt organic practices but cannot because their capital is already tied up by previous investments, policymakers will have to intervene to facilitate this transformation. If farmers are discouraged from converting to organic by industry infrastructure, policymakers need to identify regulations and industry standards that prevent the transition to organic farming, such as minimum sizes for fruits and vegetables. Second, is certified organic farming an appropriate standard for sustainable farming? Only half of the farmers who state that they only use organic farming practices are certified as such. Thus, either the farmers in our sample exaggerated the extent to which they complied with organic principles, or the certificates may not be the best form of distinction between farmers.

5.6 References

Bakker, L., 2021. Kicking the Habit_ What Makes and Breaks Farmers' Intentions to Reduce Pesticide Use? Ecol. Econ. 11.

Bartkowski, B., Bartke, S., 2018. Leverage Points for Governing Agricultural Soils: A Review of Empirical Studies of European Farmers' Decision-Making. Sustainability 10, 3179. https://doi.org/10.3390/su10093179

Bénabou, R., Tirole, J., 2016. Mindful Economics: The Production, Consumption, and Value of Beliefs. J. Econ. Perspect. 30, 141–164. https://doi.org/10.1257/jep.30.3.141

de Quidt, J., Vesterlund, L., Wilson, A.J., 2019. Experimenter demand effects, in: Schram, A., Aljaž, U. (Eds.), Handbook of Research Methods and Applications in Experimental Economics., Handbooks of Research Methods and Applications. Edward Elgar Publishing, UK, pp. 384–400.

Dessart, F.J., Barreiro-Hurlé, J., van Bavel, R., 2019. Behavioural factors affecting the adoption of sustainable farming practices: a policy-oriented review. Eur. Rev. Agric. Econ. 46, 417–471. https://doi.org/10.1093/erae/jbz019

Deter, A., 2013. "Wir haben Agrarindustrie satt": Demonstranten forderten Systemwechsel [WWW Document]. Top Agrar. URL https://www.topagrar.com/management-und-politik/news/wir-haben-agrarindustrie-satt-demonstranten-forderten-systemwechsel-9589929.html (accessed 8.15.22).

German Environment Agency, 2021. Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol 2021: National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2019 (No. 44), Climate Change National Inventory Report. German Environment Agency, Dessau-Roßlau.

German Federal Government, 2020. Deutsche Nachhaltigkeitsstrategie - Weiterentwicklung 2021, Nachhaltigkeitsstrategie für Deutschland. Die Bundesregierung, Berlin.

German Federal Government, 2016. Deutsche Nachhaltigkeitsstrategie - Neuauflage 2016, Nachhaltigkeitsstrategie für Deutschland. Die Bundesregierung, Berlin.

Golman, R., Hagmann, D., Loewenstein, G., 2017. Information Avoidance. J. Econ. Lit. 55, 96–135. https://doi.org/10.1257/jel.20151245

Jantke, K., Hartmann, M.J., Rasche, L., Blanz, B., Schneider, U.A., 2020. Agricultural Greenhouse Gas Emissions: Knowledge and Positions of German Farmers. Land 9, 130. https://doi.org/10.3390/land9050130

Kahan, D.M., Braman, D., Gastil, J., Slovic, P., Mertz, C.K., 2007. Culture and Identity-Protective Cognition: Explaining the White-Male Effect in Risk Perception. J. Empir. Leg. Stud. 4, 465–505. https://doi.org/10.1111/j.1740-1461.2007.00097.x

Loorbach, D., Frantzeskaki, N., Avelino, F., 2017. Sustainability Transitions Research: Transforming Science and Practice for Societal Change. Annu. Rev. Environ. Resour. 42. https://doi.org/10.1146/annurev-environ-102014-021340
Montada, L., Kals, E., Becker, R., 2014a. Umweltschützende Verzichtsbereitschaften, in: Zusammenstellung Sozialwissenschaftlicher Items Und Skalen (ZIS). https://doi.org/10.6102/zis70
Montada, L., Kals, E., Becker, R., 2014b. Umweltschützende Informations- und Zahlungsbereitschaften, in: Zusammenstellung Sozialwissenschaftlicher Items Und Skalen (ZIS). https://doi.org//10.6102/zis67
NABU, 2019. Verflechtungen und Interessen des Deutschen Bauernverbandes (DBV). Naturschutzbund Deutschland, Berlin/Bremen.
Nickerson, R.S., 1998. Confirmation bias: A ubiquitous phenomenon in many guises. Rev. Gen. Psychol. 2, 175.
Petty, R.E., Cacioppo, J.T., 1979. Issue involvement can increase or decrease persuasion by enhancing message-relevant cognitive responses. J. Pers. Soc. Psychol. 37, 1915–1926. https://doi.org/10.1037/0022-3514.37.10.1915
Serebrennikov, D., Thorne, F., Kallas, Z., McCarthy, S.N., 2020. Factors Influencing Adoption of Sustainable Farming Practices in Europe: A Systemic Review of Empirical Literature. Sustainability 12, 9719. https://doi.org/10.3390/su12229719
World Medical Association, 2013. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA 310, 2191–2194. https://doi.org/10.1001/jama.2013.281053
Zizzo, D.J., 2010. Experimenter demand effects in economic experiments. Exp. Econ. 13, 75–98. https://doi.org/10.1007/s10683-009-9230-z

Supplementary materials

A. Chapter 2: Supplementary material

The supplementary materials for chapter 2 are organized as follows: In supplementary section A.1, we offer a detailed account of our study methods. In section A.2, regression outputs, additional analyses and robustness checks are provided. In section A.3, study materials are presented for the interested reader.

A.1 Study methods

A.1.1 Additional details on study sites and data collection

A.1.1.1 Solomon Islands

We conducted 478 surveys in the Solomon Islands at three different study sites between March and June 2017. We interviewed 230 people living on the Reef Islands, a group of atoll islands in Temotu Province, 135 people living on the hills of the capital city Honiara on Guadalcanal, and 113 people who migrated to the capital from atoll islands such as the Reef Islands or Ontong Java and now live in the Reef Island Settlement or the Lord Howe Settlement in Honiara. In Honiara, our goal was to survey Solomon Islands residents least exposed to SLR. Therefore, we excluded all coastal neighborhoods, flood-prone areas, and neighborhoods where more than 60% of residents had recently migrated to Honiara from another island. Therefore, the wards Vavaea, Vuhokesa, and Panatina with 64%, 86%, and 100% migration rates, respectively, were eliminated as potential study sites. In addition, we excluded Rove/Langakiki because we pretested our survey with people from this ward and our research team stayed in this area for the duration of our research and many people knew us personally. For the remaining wards, Nggossi, Mbumburu, Mataniko, Kola'a, Kukum, Vura, and Panatina, we used population percentages to assign tickets from 1 to 100. Drawing two random tickets, we obtained Mataniko and Vura. Each ward is further divided into enumeration areas (EAs). Mataniko consists of 9 EAs. We excluded EA 1 because it includes the Lord Howe Settlement. EA 2, 3, and 4 were excluded because these neighborhoods are mainly home to Chinese migrants and foreign experts. Out of the remaining EAs, EA 6 and EA 7 were randomly selected. Our second ward, Vura, consists of 20 EAs. EA 20 was excluded because of its coastal location. Of the remaining 19 EAs, EA 13 and EA 14 were randomly selected. We created a complete household list for all six research sites in Honiara, EA 6 and 7 in Mataniko, EA 13 and 14 in Vura, Lord Howe Settlement, and Reef Island Settlement, from which we randomly selected households for the survey.

A.1.1.2 Vietnam

In the Ca Mau and Bac Lieu provinces, we observed multiple examples of government investments in making the regions more robust to SLR.

Fig. A.1 Elevated roads in Ca Mau province

Notes: Picture made by Matthias Mayer during fieldwork in 2019.

Fig. A.2 Sea walls in Ganh Hao, Bac Lieu province

Notes: Picture made by Matthias Mayer during fieldwork in 2019.

A.1.2 Sample overview

Table A.1 Detailed sample description

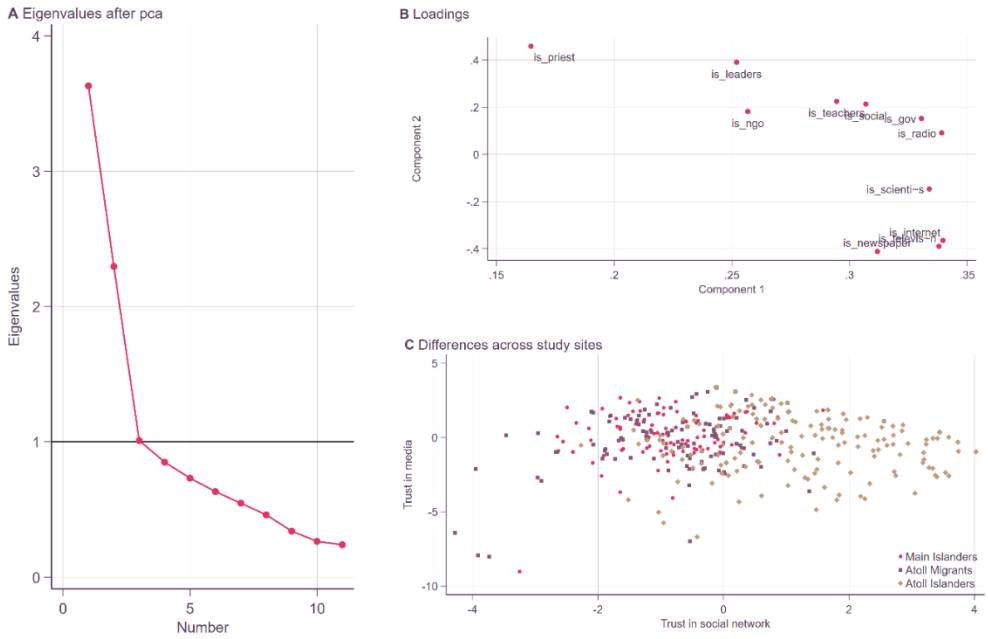
VARIABLES	(1) United States Mean/SD	(2) Solomon Islands Mean/SD	(3) Bangladesh Mean/SD	(4) Vietnam Mean/SD	(5) Pooled Mean/SD
Outcome variables					
Ignore SLR risks (=1)	0.26	0.09	0.20	0.07	0.17
	[0.44]	[0.28]	[0.40]	[0.26]	[0.38]
Ignore SLR other (=1)	0.45	0.68	0.22	0.04	0.40
	[0.50]	[0.47]	[0.42]	[0.20]	[0.49]
Don't ignore any information (=1)	0.29	0.23	0.58	0.89	0.42
	[0.46]	[0.42]	[0.49]	[0.32]	[0.49]
Sociodemographics					
Age	40.43	37.37	34.98	44.92	39.88
	[12.66]	[14.21]	[12.14]	[14.12]	[13.61]
Female (=1)	0.50	0.42	0.46	0.61	0.49
	[0.50]	[0.49]	[0.50]	[0.49]	[0.50]
Education (years)	15.13	8.09	7.48	6.37	10.88
	[2.06]	[3.29]	[4.62]	[4.28]	[5.07]
Household income (pp in $US)	24266.82	41.84	110.87	360.06	11064.48
	[20339.60]	[59.34]	[95.52]	[289.95]	[18192.50]
Climate change beliefs					
CC will get worse (1-5)	4.10	4.34	3.43	3.85	4.03
	[0.83]	[0.68]	[0.72]	[0.78]	[0.82]
Conspiracy (1-5)	1.99	-	1.71	1.06	1.72
	[1.25]		[0.82]	[0.34]	[1.11]
Knowledge (0-10)	7.87	-	4.11	5.98	6.82
	[1.79]		[3.40]	[2.96]	[2.80]
Having to relocate (0-10)	3.54	-	3.72	3.64	3.59
	[3.22]		[3.45]	[3.53]	[3.33]
Information sources					
Trust in mainstream media (1-5)	3.16	-	-	-	-
	[1.15]				
Trust in Fox News (1-5)	2.44	-	-	-	-
	[1.47]				
Media (PCA)	-0.01	-0.01	-0.00	0.01	-0.00
	[2.08]	[1.90]	[1.11]	[1.08]	[1.79]
Social network (PCA)	0.00	0.01	0.00	0.02	0.01
	[1.33]	[1.52]	[1.50]	[1.53]	[1.43]
Exposure					
FEMA risk rating (0-5)	0.84	-	-	-	-
	[1.37]				
Coastal county (=1)	0.28	-	-	-	-
	[0.45]				
Atoll residents (=1)	-	0.48	-	-	-
		[0.50]			
Atoll migrant (=1)	-	0.24	-	-	-
		[0.43]			
Main islander (=1)	-	0.28	-	-	-
		[0.45]			
Distance to urban center (km)	-	-	22.77	32.80	28.94
			[12.90]	[23.11]	[20.39]
Land lost (=1)	-	-	0.34	0.14	0.22
			[0.48]	[0.34]	[0.41]
Rebuild (=1)	-	-	0.52	0.21	0.33
			[0.50]	[0.41]	[0.47]
Other control variables (U.S. only)					
Liberal (=1)	0.36	-	-	-	-
	[0.48]				
Conservative (=1)	0.26	-	-	-	-
	[0.44]				
County Gov. Republican (=1)	0.51	-	-	-	-
	[0.50]				
Numeracy (0-3)	2.52	-	-	-	-
	[0.77]				

Literacy (1-7)	5.73 [1.34]	-	-	-	-
Dogmatism (1-7)	3.94 [1.11]	-	-	-	-
Observations	478	478	229	366	1958

A.1.3 Measurement details

In the Solomon Islands, we asked respondents on a scale from 1 "not important at all" to 5 "very important" how important the following information sources are to them: (i) family, friends and neighbors, (ii) teachers, (iii) television, (iv) internet, (v) newspapers, (vi) radio, (vii) community leaders, (viii) local priests, (ix) government officials, (x) NGO workers, (xi) scientists. Using PCA, we identified two components (α = .785, kmo = .768). One encompasses sources of information belonging to the media, such as television, newspapers, government officials, etc. The other component contains sources of information belonging to the respondent's social network, such as family, friends and neighbors, teachers, community leaders, etc. (see Fig. A.3B).

Fig. A.3 Importance of information sources in the Solomon Islands

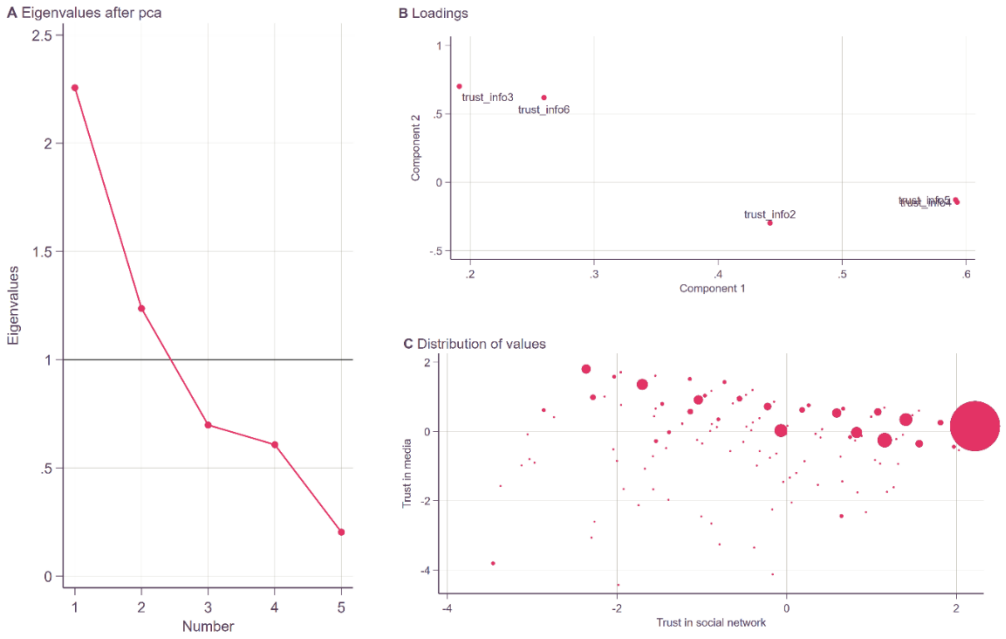


Notes: Fig. A.3 panel A shows the eigenvalues after PCA, panel B the loadings of the different factors, and panel C the resulting scores for each respondent given the study site, that is whether respondents are living on the main islands, are migrants from atoll islands, or still live on an atoll island.

In Bangladesh and Vietnam, we asked respondents how much they trust (i) religious organizations, (ii) NGOs and scientists, (iii) friends and family, (iv) people from their village, or (v) the media to tell them the truth about climate change on a scale from 1 "strongly distrust" to 5 "strongly trust". Using PCA, we identified two components (α_{bd} = .681, kmo_{bd} = .634; α_{vn} = .708, kmo_{vn} = .657). We did not ask respondents if they trusted their government to tell the truth about climate change, as this was considered

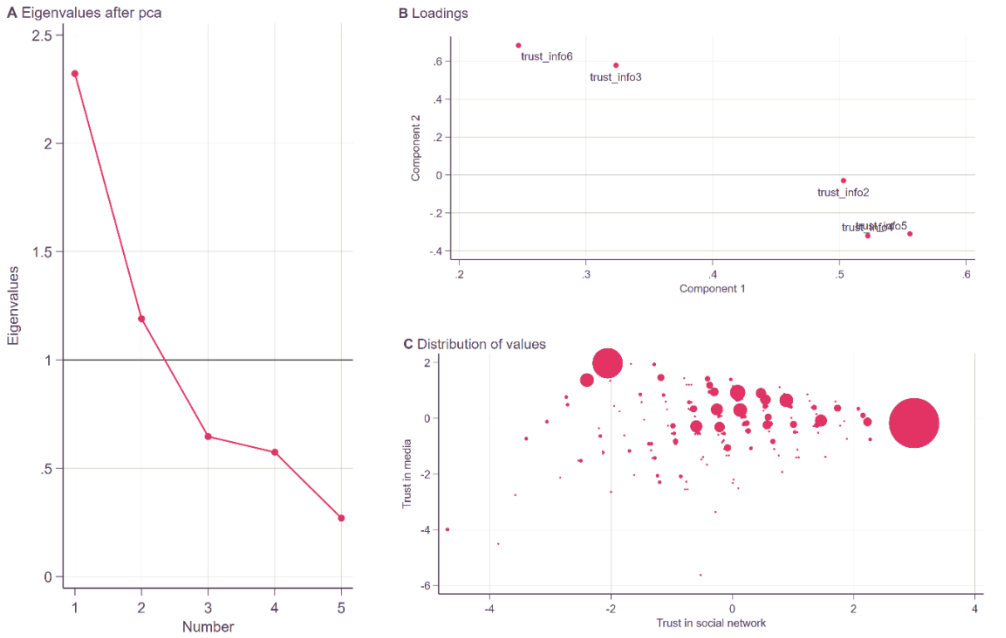
inappropriate by our local partners. Respondents might have felt uncomfortable answering this question or would have given inaccurate answers.

Fig. A.4 Importance of information sources in Bangladesh



Notes: Fig. A.4 panel A shows the eigenvalues after PCA, panel B the loadings of the different factors, and panel C the resulting scores for each respondent.

Fig. A.5 Importance of information sources in Vietnam



Notes: Fig. A.5 panel A shows the eigenvalues after PCA, panel B the loadings of the different factors, and panel C the resulting scores for each respondent.

A.2 Additional results and robustness checks

This section provides additional results and robustness checks of our findings. The structure of this section follows the outline of the main manuscript starting with the survey experiment, continuing with the findings from the balanced panel, and concluding with a detailed look at vaccination hesitancy.

A.2.1 Study 1: United States

A.2.1.1 Reasons

Table A.2 Overlap between reasons to ignore SLR risk information

	Not trustworthy	Contradicts my beliefs	Based on bad science	Belly decision	Doesn't depict the truth	Not important for Americans like me	Total times reason was mentioned
Not trustworthy	x						104
Contradicts my beliefs	68	x					128
Based on bad science	56	63	x				82
Belly decision	57	80	44	x			118
Doesn't depict the truth	84	84	66	66	x		123
Not important for Americans like me	62	61	50	53	69	x	90
Total times a reason was given							231

Note: Table A.2 shows the overlap between reasons given by respondents for why they stated that the information on SLR risks should be ignored by Americans like themselves. The total number of each reason selected is presented in column 7.

Table A.3 Overlap between reasons to ignore SLR adaptation information

	Not trustworthy	Contradicts my beliefs	Based on bad science	Belly decision	Doesn't depict the truth	Not important for Americans like me	Total times reason was mentioned
Not trustworthy	x						289
Contradicts my beliefs	247	x					285
Based on bad science	235	220	x				257
Belly decision	114	118	100	x			152
Doesn't depict the truth	270	265	247	130	x		333
Not important for Americans like me	89	87	80	52	94	x	102
Total times a reason was given							403

Note: Table A.3 shows the overlap between reasons given by respondents for why they stated that the information on adaptation options should be ignored by Americans like themselves. The total number of each reason selected is presented in column 7.

Table A.4 Overlap between reasons to ignore no information

	Both are equally important /relevant	Both are equally unimportant /irrelevant	I couldn't decide	I don't care	Total times reason was mentioned
Both are equally	x				244

important/relevant					
Both are equally unimportant/irrelevant	0	x			7
I couldn't decide	0	0	x		6
I don't care	0	0	0	x	2
Total times a reason was given					259

Note: Table A.4 shows the reasons respondents mentioned for stating that no information should be ignored. Since respondents could only select one reason, there is no overlap between reasons. The total number of each reason selected is presented in column 5.

Table A.5 Reasons to ignore SLR risk information given the strength of ignoring

	(1) Ignore SLR risks -1, -2, & -3		(2) Ignore SLR risks -4 & -5		(3) p-value for difference	
	Mean	SD	Mean	SD	Diff.	T-stat.
It didn't seem trustworthy	0.458	0.501	0.451	0.500	0.007	(0.108)
It contradicts my beliefs	0.449	0.500	0.656	0.477	-0.207**	(-3.197)
It is based on bad research	0.280	0.451	0.418	0.495	-0.138*	(-2.200)
It was a gut decision	0.467	0.501	0.557	0.499	-0.090	(-1.360)
It doesn't depict the truth	0.523	0.502	0.549	0.500	-0.026	(-0.389)
I don't think this is important for Americans like me	0.393	0.491	0.393	0.491	-0.001	(-0.014)
Observations	107		122		229	

Note: Table A.5 depicts the reasons stated for ignoring the SLR risk information given the strength of which this information should be ignored. Respondents were asked, what information (if any) should be ignored by Americans like you?" Respondents could select one of the values on the scale ranging from -5 "the SLR risk information should be completely ignored" to 5 "the SLR adaptation information should be completely ignored" with 0 in the center indicating "no information should be ignored." Column 1 presents mean values and standard deviations for values -1, -2, or -3 and column 2 for values -4 or -5. Column 3 shows the differences between these two groups and the corresponding t-statistic. *** p<0.01, ** p<0.05, * p<0.1.

Table A.6 Reasons to ignore SLR risk information stated by respondents who believed they have to relocate due to SLR

	(1) Ignore SLR (=1) & Relocate (=0)		(2) Ignore SLR (=1) & Relocate (=1)		(3) diff	
	Mean	SD	Mean	SD	b	T- stat.
It didn't seem trustworthy	0.451	0.499	0.459	0.501	-0.007	(-0.109)
It contradicts my beliefs	0.535	0.501	0.600	0.493	-0.065	(-0.963)
It is based on bad research	0.340	0.475	0.376	0.487	-0.036	(-0.548)
It was a gut decision	0.472	0.501	0.588	0.495	-0.116	(-1.706)
It doesn't depict the truth	0.563	0.498	0.494	0.503	0.068	(0.998)
I don't think this is important for Americans like me	0.389	0.489	0.400	0.493	-0.011	(-0.165)
Observations	144		85		229	

Note: Table A.6 shows in column 1 the reasons respondents gave for ignoring information about SLR risks and not believing they will have to relocate in the near future due to SLR. Column 2 shows the reasons respondents gave for ignoring information about SLR risks and believing they will have to relocate due to SLR. The latter group of respondents is slightly more likely to state that ignoring the SLR risk information was an intuitive gut decision.

A.2.1.2 Empirical models & robustness checks

Table A.7 Correlation between climate change beliefs and political orientation among respondents who stated that the SLR risk information should be ignored

VARIABLES	(1) CC will get worse (1-5)	(2) CC conspiracy beliefs (1-5)	(3) CC Knowledge (0-10)	(4) Having to relocate (0-10)
Liberal (=1)	0.53***	-0.14	1.13***	1.11*
	(0.16)	(0.26)	(0.35)	(0.65)
Conservative (=1)	0.14	1.09***	0.84***	1.49***
	(0.12)	(0.17)	(0.28)	(0.52)
Constant	3.56***	2.49***	7.25***	4.32***
	(0.10)	(0.14)	(0.24)	(0.40)
Observations	229	229	229	229
Adjusted R-squared	0.04	0.20	0.05	0.02

Notes: Table A.7 presents the correlation between climate change beliefs and political orientation of respondents who stated that the piece of information highlighting the SLR risks to the United States should be ignored.

Table A.8 Correlation between climate change beliefs and trust in media among respondents who stated that the SLR risk information should be ignored

VARIABLES	(1) CC will get worse (1-5)	(2) CC conspiracy beliefs (1-5)	(3) CC Knowledge (0-10)	(4) Having to relocate (0-10)
Trust in mainstream media (1-5)	0.36***	-0.18**	0.27**	1.84***
	(0.06)	(0.08)	(0.13)	(0.14)
Trust in Fox News (1-5)	-0.09**	0.44***	0.01	-0.00
	(0.05)	(0.06)	(0.09)	(0.15)
Constant	2.85***	2.22***	7.02***	-0.67
	(0.18)	(0.26)	(0.38)	(0.49)
Observations	229	229	229	229
Adjusted R-squared	0.22	0.18	0.03	0.41

Notes: Table A.8 presents the correlation between climate change beliefs and trust in the media of respondents who stated that the piece of information highlighting the SLR risks to the United States should be ignored.

Table A.9 Determinants of ignoring sea-level rise risk in the United States

VARIABLES	(1) Ignore SLR (0-5)	(2) Ignore SLR (0-5)	(3) Ignore SLR (0-5)	(4) Ignore SLR (0-5)	(5) Ignore SLR (0-5)	(6) Ignore SLR (0-5)
Climate change beliefs						
CC will get worse (1-5)	-0.05					-0.08
	(0.07)					(0.07)
Conspiracy (1-5)	0.55***					0.41***
	(0.06)					(0.07)
Knowledge (0-10)	0.10***					0.08***
	(0.03)					(0.03)
Having to relocate (0-10)	0.11***					0.07***
	(0.02)					(0.02)
Information sources						
Trust in m. media (1-5)		-0.03				0.07
		(0.05)				(0.05)
Trust in Fox News (1-5)		0.33***				-0.04
		(0.04)				(0.05)
Political orientation						
Liberal (=1)			-0.03			0.01
			(0.10)			(0.10)
Conservative (=1)			1.28***			0.35**

			(0.15)			(0.16)
County variables						
County Gov. Rep. (=1)				0.42***		0.11
				(0.11)		(0.09)
FEMA risk rating (0-5)				0.10		-0.00
				(0.07)		(0.06)
Coastal county (=1)				-0.22		-0.06
				(0.21)		(0.18)
Other control variables						
Numeracy (0-3)					-0.42***	-0.20**
					(0.08)	(0.08)
Literacy (1-7)					-0.25***	-0.16***
					(0.05)	(0.05)
Dogmatism (1-7)					0.29***	0.08*
					(0.05)	(0.04)
Constant	-0.69	0.16	0.50	-0.01	1.83***	0.64
	(0.49)	(0.37)	(0.36)	(0.39)	(0.52)	(0.61)
Socioeconomics	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	893	893
Adjusted R-squared	0.31	0.13	0.17	0.07	0.23	0.35

Note: The dependent variable is the degree to which respondents stated that the information should be ignored by Americans like themselves. The outcome variable ranges from 0 "should not be ignored" to 5 "should be completely ignored. Here, respondents who reported that the SLR risk information should be ignored are compared to all other respondents. Those who stated that no information should be ignored as well as those who stated that the information on adaptation opportunities should be ignored. All regression models (1) – (6) control for respondents' age, gender, having a master's degree or higher, and adjusted household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.10 Determinants of ignoring sea-level rise risk in the United States (Probit)

VARIABLES	(1) Ignore SLR (=1)	(2) Ignore SLR (=1)	(3) Ignore SLR (=1)	(4) Ignore SLR (=1)	(5) Ignore SLR (=1)	(6) Ignore SLR (=1)
Climate change beliefs						
CC will get worse (1-5)	-0.24***					-0.26***
	(0.08)					(0.08)
Conspiracy (1-5)	0.42***					0.26***
	(0.05)					(0.06)
Knowledge (0-10)	0.03					0.02
	(0.03)					(0.03)
Having to relocate (0-10)	0.11***					0.09***
	(0.02)					(0.02)
Information sources						
Trust in m. media (1-5)		-0.13***				-0.02
		(0.05)				(0.06)
Trust in Fox News (1-5)		0.31***				0.00
		(0.04)				(0.05)
Political orientation						
Liberal (=1)			-0.20			-0.07
			(0.12)			(0.14)
Conservative (=1)			0.97***			0.36**
			(0.12)			(0.15)
County variables						
County Gov. Rep. (=1)				0.41***		0.22*
				(0.10)		(0.11)
FEMA risk rating (0-5)				0.11*		0.08
				(0.07)		(0.07)
Coastal county (=1)				-0.23		-0.23
				(0.20)		(0.22)
Other control variables						
Numeracy (0-3)					-0.33***	-0.21***
					(0.07)	(0.08)
Literacy (1-7)					-0.20***	-0.12***
					(0.04)	(0.05)
Dogmatism (1-7)					0.25***	0.04
					(0.05)	(0.06)

Constant	-0.13	-0.60	-0.48	-1.05***	0.42	1.10
	(0.57)	(0.41)	(0.41)	(0.39)	(0.52)	(0.67)
Socioeconomics	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	893	893
Pseudo R-squared	0.27	0.13	0.16	0.08	0.19	0.32

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

Table A.11 Determinants of ignoring sea-level rise risk in the United States (binary outcome using strict classification)

VARIABLES	(1) Ignore SLR (=1)	(2) Ignore SLR (=1)	(3) Ignore SLR (=1)	(4) Ignore SLR (=1)	(5) Ignore SLR (=1)	(6) Ignore SLR (=1)
Climate change beliefs						
CC will get worse (1-5)	-0.10					-0.13
	(0.08)					(0.08)
Conspiracy (1-5)	0.43***					0.31***
	(0.05)					(0.06)
Knowledge (0-10)	0.10***					0.08**
	(0.04)					(0.04)
Having to relocate (0-10)	0.09***					0.06***
	(0.02)					(0.02)
Information sources						
Trust in m. media (1-5)		-0.04				0.03
		(0.05)				(0.06)
Trust in Fox News (1-5)		0.29***				0.00
		(0.04)				(0.05)
Political orientation						
Liberal (=1)			-0.01			0.02
			(0.13)			(0.15)
Conservative (=1)			0.96***			0.21
			(0.13)			(0.16)
County variables						
County Gov. Rep. (=1)				0.33***		0.08
				(0.10)		(0.12)
FEMA risk rating (0-5)				0.11		0.03
				(0.07)		(0.08)
Coastal county (=1)				-0.25		-0.14
				(0.21)		(0.24)
Other control variables						
Numeracy (0-3)					-0.26***	-0.13
					(0.07)	(0.08)
Literacy (1-7)					-0.22***	-0.16***
					(0.04)	(0.05)
Dogmatism (1-7)					0.37***	0.16**
					(0.06)	(0.06)
Constant	-2.25***	-1.81***	-1.56***	-1.92***	-1.03*	-1.31*
	(0.62)	(0.45)	(0.43)	(0.43)	(0.60)	(0.74)
Socioeconomics	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	893	893
Pseudo R-squared	0.27	0.13	0.15	0.07	0.22	0.31

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

Table A.12 Determinants of ignoring SLR adaptation information in the United States (binary outcome)

VARIABLES	(1) Ignore SLR adaptation	(2) Ignore SLR adaptation	(3) Ignore SLR adaptation	(4) Ignore SLR adaptation	(5) Ignore SLR adaptation	(6) Ignore SLR adaptation

	(=1)	(=1)	(=1)	(=1)	(=1)	(=1)
Climate change beliefs						
CC will get worse (1-5)	0.18**					0.10
	(0.07)					(0.07)
Conspiracy (1-5)	-0.47***					-0.27***
	(0.05)					(0.06)
Knowledge (0-10)	0.04					0.03
	(0.03)					(0.03)
Having to relocate (0-10)	-0.06***					-0.06***
	(0.02)					(0.02)
Information sources						
Trust in m. media (1-5)		0.33***				0.17***
		(0.04)				(0.05)
Trust in Fox News (1-5)		-0.36***				-0.08*
		(0.04)				(0.04)
Political orientation						
Liberal (=1)			0.59***			0.37***
			(0.10)			(0.11)
Conservative (=1)			-0.85***			-0.29**
			(0.12)			(0.14)
County variables						
County Gov. Rep. (=1)				-0.25***		-0.02
				(0.09)		(0.10)
FEMA risk rating (0-5)				-0.02		0.01
				(0.06)		(0.07)
Coastal county (=1)				0.09		0.13
				(0.18)		(0.21)
Other control variables						
Numeracy (0-3)					0.46***	0.41***
					(0.07)	(0.08)
Literacy (1-7)					0.15***	0.08*
					(0.04)	(0.04)
Dogmatism (1-7)					-0.12***	0.01
					(0.04)	(0.05)
Constant	-0.66	-0.49	-0.47	0.07	-1.70***	-2.33***
	(0.51)	(0.37)	(0.37)	(0.36)	(0.46)	(0.64)
Socioeconomics	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	893	893
Pseudo R-squared	0.20	0.13	0.13	0.02	0.11	0.26

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

Table A.13 Determinants of ignoring SLR adaptation information in the United States (binary outcome using strict classification)

VARIABLES	(1) Ignore SLR adaptation (=1)	(2) Ignore SLR adaptation (=1)	(3) Ignore SLR adaptation (=1)	(4) Ignore SLR adaptation (=1)	(5) Ignore SLR adaptation (=1)	(6) Ignore SLR adaptation (=1)
Climate change beliefs						
CC will get worse (1-5)	0.23***					0.16**
	(0.07)					(0.07)
Conspiracy (1-5)	-0.47***					-0.29***
	(0.06)					(0.07)
Knowledge (0-10)	0.07**					0.06*
	(0.03)					(0.03)
Having to relocate (0-10)	-0.04***					-0.05**
	(0.02)					(0.02)
Information sources						
Trust in m. media (1-5)		0.37***				0.20***
		(0.05)				(0.05)
Trust in Fox News (1-5)		-0.34***				-0.08*
		(0.04)				(0.05)
Political orientation						
Liberal (=1)			0.52***			0.19*

			(0.10)			(0.11)
Conservative (=1)			-0.87***			-0.38**
			(0.13)			(0.15)
County variables						
County Gov. Rep. (=1)				-0.21**		0.00
				(0.09)		(0.10)
FEMA risk rating (0-5)				0.01		0.03
				(0.06)		(0.07)
Coastal county (=1)				0.05		0.12
				(0.18)		(0.22)
Other control variables						
Numeracy (0-3)					0.36***	0.28***
					(0.07)	(0.08)
Literacy (1-7)					0.14***	0.05
					(0.04)	(0.04)
Dogmatism (1-7)					-0.07	0.05
					(0.04)	(0.05)
Constant	-1.56***	-0.98**	-0.84**	-0.35	-1.89***	-2.93***
	(0.52)	(0.38)	(0.37)	(0.36)	(0.47)	(0.65)
Socioeconomics	YES	YES	YES	YES	YES	YES
Observations	893	893	893	893	893	893
Pseudo R-squared	0.20	0.13	0.12	0.02	0.07	0.24

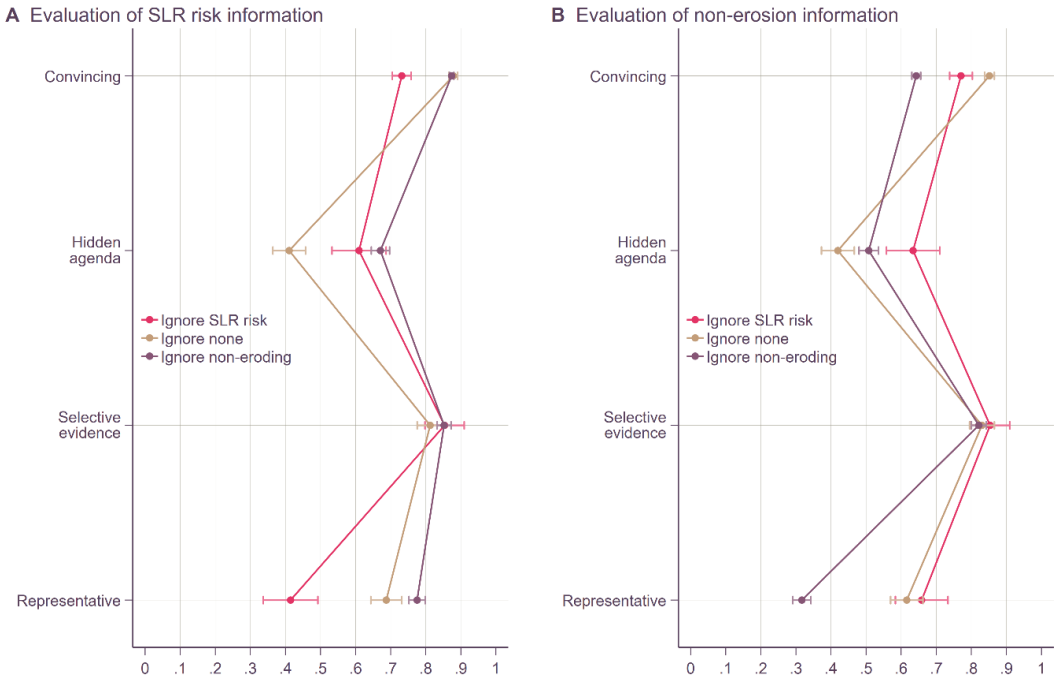
Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

A.2.2 Study 2: Solomon Islands

A.2.2.1 Reasons

Before respondents were asked if either of the information pieces should be ignored by other Solomon Islanders like themselves, we asked them to evaluate each piece of information (Fig. A.6). Both pieces of information were perceived as convincing, although the SLR risk information was perceived as slightly more convincing than the information on non-eroding islands (T-Test diff. = .160, $t_{478} = 14.214$, $p < .001$). Compared to those not ignoring any information, respondents who stated that the SLR risk information should be ignored perceived this information as less convincing (T-Test diff. = -.147, $t_{153} = -5.599$, $p < .001$) and were significantly less likely to view it as representative of other atolls in the Solomon Islands (T-Test diff. = -.273, $t_{153} = -3.150$, $p < .002$). Similarly, respondents declaring that the information on non-eroding atolls should be ignored, also perceive this information as less convincing (T-Test diff. = -.209, $t_{437} = -9.120$, $p < .001$) and less representative (T-Test diff. = -.299, $t_{437} = -5.786$, $p < .001$). In addition, respondents who indicated that no information should be ignored were less likely to suspect hidden agendas on the part of the authors of the studies on which the two pieces of information were based (SLR riks information: T-Test diff. = -.253, $t_{478} = -4.906$, $p < .001$; non-erosion information: T-Test diff. = -.102, $t_{478} = -1.896$, $p < .059$).

Fig. A.6 Respondents' information given their decision to (not) ignore



Notes: Fig. A6 shows respondents' assessment of the two pieces of information presented. Mean values and 95-confidence intervals are shown for respondents who indicated that SLR risk information, no information, or non-eroding atoll information should be ignored. Panel A shows respondents' assessment of SLR risk information and Panel B shows their assessment of no erosion information.

A.2.2.2 Empirical models & robustness checks

Table A.14 Determinants of ignoring SLR risks in the Solomon Islands

VARIABLES	(1) Ignore Risks (0-5)	(2) Ignore Risks (0-5)	(3) Ignore Risks (0-5)	(4) Ignore Risks (0-5)
Climate change beliefs				
CC will get worse (1-5)	-0.27			-0.29
	(0.18)			(0.19)
Importance of CC (1-10)	-0.17***			-0.14**
	(0.05)			(0.06)
Conspiracy (=1)	0.06			-0.21
	(0.69)			(0.61)
Information sources				
Media (PCA)		0.14*		0.10
		(0.08)		(0.08)
Social network (PCA)		-0.21***		-0.08
		(0.07)		(0.08)
Exposure				
Atoll residents (=1)			-0.58	0.30
			(0.39)	(0.41)
Atoll migrant (=1)			0.59	0.92**
			(0.40)	(0.36)
Constant	2.61**	0.15	0.93	2.18*
	(1.01)	(0.53)	(0.58)	(1.10)
Socioeconomics	yes	yes	yes	yes
Observations	153	153	153	153
Adjusted R-squared	0.09	0.05	0.05	0.12

Note: Table A.14 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Solomon Islanders like themselves. The outcome variable ranges from 0 "no information should be ignored" to 5 "SLR risk information should be completely ignored." All regression (1) – (4) control for respondents' age, gender,

years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.15 Determinants of ignoring information on non-eroding atolls in the Solomon Islands

VARIABLES	(1) Ignore non-eroding atolls (0-5)	(2) Ignore non-eroding atolls (0-5)	(3) Ignore non-eroding atolls (0-5)	(4) Ignore non-eroding atolls (0-5)
Climate change beliefs				
CC will get worse (1-5)	0.03			-0.20
	(0.15)			(0.15)
Importance of CC (1-10)	0.02			0.03
	(0.04)			(0.04)
Conspiracy (=1)	-0.02			-0.03
	(0.31)			(0.30)
Information sources				
Media (PCA)		0.03		0.05
		(0.04)		(0.04)
Social network (PCA)		-0.11*		-0.15**
		(0.06)		(0.06)
Exposure				
Atoll residents (=1)			1.07***	1.39***
			(0.28)	(0.32)
Atoll migrant (=1)			1.60***	1.71***
			(0.22)	(0.23)
Constant	2.39***	2.66***	1.48***	1.85**
	(0.84)	(0.44)	(0.47)	(0.80)
Socioeconomics	yes	yes	yes	yes
Observations	437	437	437	437
Adjusted R-squared	0.02	0.03	0.11	0.12

Note: Table A.15 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Solomon Islanders like themselves. The outcome variable ranges from 0 "no information should be ignored" to 5 "the information stating that not all atolls are eroding should be ignored." All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.16 Determinants of ignoring information on non-eroding atolls in the Solomon Islands (binary outcome)

VARIABLES	(1) Ignore non-eroding atolls (=1)	(2) Ignore non-eroding atolls (=1)	(3) Ignore non-eroding atolls (=1)	(4) Ignore non-eroding atolls (=1)
Climate change beliefs				
CC will get worse (1-5)	0.13			0.08
	(0.10)			(0.11)
Importance of CC (1-10)	0.00			0.02
	(0.03)			(0.03)
Conspiracy (=1)	0.23			0.27
	(0.28)			(0.30)
Information sources				
Media (PCA)		-0.02		-0.02
		(0.03)		(0.03)
Social network (PCA)		-0.03		-0.01
		(0.05)		(0.05)
Exposure				
Atoll residents (=1)			0.14	0.07
			(0.23)	(0.26)
Atoll migrant (=1)			0.98***	0.94***
			(0.22)	(0.22)

Constant	0.18	0.77**	0.48	0.02
	(0.60)	(0.33)	(0.40)	(0.63)
Socioeconomics	yes	yes	yes	yes
Observations	437	437	437	437
Pseudo R-squared	0.02	0.02	0.07	0.07

Notes: Table A.16 presents coefficient estimates from linear probability models of the outcome variable that equals 0 if respondents stated that no information should be ignored and 1 if they stated that the information that not all atoll islands will erode should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.17 Determinants of ignoring information on non-eroding atolls in the Solomon Islands (binary outcome using strict classification)

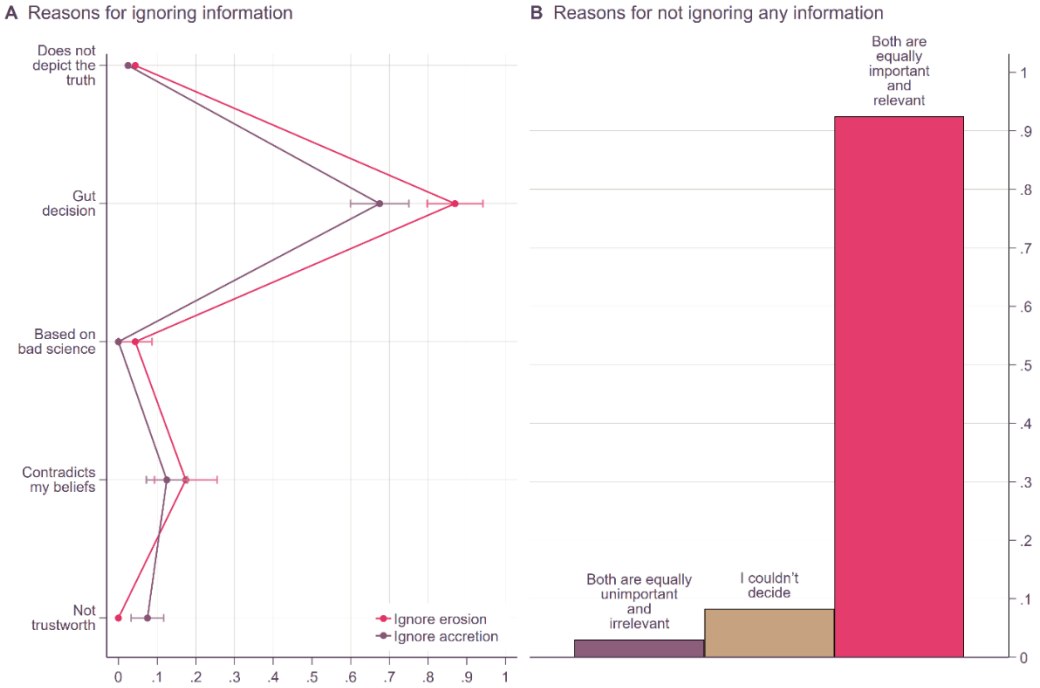
VARIABLES	(1) Ignore non-eroding atolls (=1)	(2) Ignore non-eroding atolls (=1)	(3) Ignore non-eroding atolls (=1)	(4) Ignore non-eroding atolls (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.04			-0.22**
	(0.10)			(0.11)
Importance of CC (1-10)	0.03			0.03
	(0.03)			(0.03)
Conspiracy (=1)	-0.03			-0.06
	(0.25)			(0.26)
Information sources				
Media (PCA)		0.01		0.02
		(0.03)		(0.03)
Social network (PCA)		-0.06		-0.12**
		(0.04)		(0.05)
Exposure				
Atoll residents (=1)			0.92***	1.22***
			(0.23)	(0.26)
Atoll migrant (=1)			0.87***	0.99***
			(0.18)	(0.19)
Constant	-0.06	-0.03	-0.91***	-0.42
	(0.56)	(0.31)	(0.35)	(0.59)
Socioeconomics	yes	yes	yes	yes
Observations	437	437	437	437
Pseudo R-squared	0.02	0.02	0.06	0.08

Notes: Table A.17 presents coefficient estimates from linear probability models of the outcome variable that equals 0 if respondents stated that no information should be ignored and 1 if they stated that the information that not all atoll islands will erode should be ignored by selecting values 3, 4, or 5 on the ignore scale. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

A.2.3 Study 3: Bangladesh

A.2.3.1 Reasons

Fig. A.7 Reasons stated for (not) ignoring information in Bangladesh



Notes: Fig. A.7 shows the reasons stated by respondents in Bangladesh for why the information should or should not be ignored. Panel A presents average values and 95% confidence intervals for respondents stating that the erosion information or the accretion information should be ignored. Panel B shows respondents' main reasons for stating that no information should be ignored.

A.2.3.2 Empirical models & robustness checks

Table A.18 Determinants of ignoring erosion information in Bangladesh (OLS)

VARIABLES	(1) Ignore erosion (=1)	(2) Ignore erosion (=1)	(3) Ignore erosion (=1)	(4) Ignore erosion (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.09*			-0.09*
	(0.05)			(0.05)
Conspiracy (1-5)	-0.01			-0.01
	(0.05)			(0.05)
Knowledge (0-10)	0.03***			0.03***
	(0.01)			(0.01)
Having to relocate (0-10)	0.00			0.00
	(0.01)			(0.01)
Information sources				
Media (PCA)		-0.01		-0.01
		(0.03)		(0.04)
Social network (PCA)		0.02		0.03
		(0.02)		(0.02)
Exposure				
Distance to urban center (10km)			0.02	0.02
			(0.02)	(0.02)
Land lost (=1)			0.00	0.04
			(0.07)	(0.07)
Rebuild (=1)			0.06	0.04
			(0.07)	(0.07)

Constant	0.75***	0.50***	0.42**	0.68***
	(0.24)	(0.15)	(0.17)	(0.24)
Socioeconomics	yes	yes	yes	yes
Observations	177	177	177	177
Pseudo R-squared	0.09	0.02	0.02	0.08

Note: Table A-18 presents coefficients from ordinary least square estimations, where the dependent variable equals 1 if respondents stated that the erosion information should be ignored by Bangladeshis like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.19 Determinants of ignoring erosion information in Bangladesh (Probit)

VARIABLES	(1) Ignore erosion (=1)	(2) Ignore erosion (=1)	(3) Ignore erosion (=1)	(4) Ignore erosion (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.29*			-0.29*
	(0.16)			(0.15)
Conspiracy (1-5)	-0.00			0.01
	(0.16)			(0.16)
Knowledge (0-10)	0.10***			0.11***
	(0.04)			(0.04)
Having to relocate (0-10)	0.02			0.01
	(0.03)			(0.03)
Information sources				
Media (PCA)		-0.05		-0.06
		(0.10)		(0.11)
Social network (PCA)		0.07		0.10
		(0.07)		(0.08)
Exposure				
Distance to urban center (10km)			0.08	0.05
			(0.08)	(0.09)
Land lost (=1)			-0.02	0.11
			(0.23)	(0.24)
Rebuild (=1)			0.24	0.15
			(0.23)	(0.23)
Constant	0.98	0.23	0.03	0.71
	(0.85)	(0.54)	(0.58)	(0.84)
Socioeconomics	yes	yes	yes	yes
Observations	177	177	177	177
Pseudo R-squared	0.12	0.05	0.06	0.14

Notes: Table A.19 presents coefficient estimates from linear probability models of the outcome variable that equals 1 if respondents stated that the erosion information should be ignored by Bangladeshis like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.20 Determinants of the strength of ignoring erosion information in Bangladesh (OLS)

VARIABLES	(1) Ignore erosion (0-5)	(2) Ignore erosion (0-5)	(3) Ignore erosion (0-5)	(4) Ignore erosion (0-5)
Climate change beliefs				
CC will get worse (1-5)	-0.12			-0.14
	(0.13)			(0.13)
Conspiracy (1-5)	0.18			0.15
	(0.15)			(0.16)
Knowledge (0-10)	0.10***			0.09**
	(0.04)			(0.04)
Having to relocate (0-10)	-0.00			-0.01

	(0.03)			(0.03)
Information sources				
Media (PCA)		-0.03		-0.00
		(0.13)		(0.13)
Social network (PCA)		-0.13*		-0.09
		(0.07)		(0.07)
Exposure				
Distance to urban center (10km)			0.12	0.07
			(0.08)	(0.08)
Land lost (=1)			0.12	0.27
			(0.23)	(0.22)
Rebuild (=1)			0.17	0.09
			(0.21)	(0.21)
Constant	0.96	1.00*	0.55	0.84
	(0.74)	(0.51)	(0.59)	(0.76)
Socioeconomics	yes	yes	yes	yes
Observations	177	177	177	177
Adjusted R-squared	0.06	0.02	0.02	0.05

Note: Table A.20 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Bangladeshis like themselves. The outcome variable ranges from 0 "no information should be ignored" to 5 "the erosion information should be completely ignored." All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.21 Determinants of ignoring the accretion information in Banglades (OLS)

VARIABLES	(1) Ignore accretion (=1)	(2) Ignore accretion (=1)	(3) Ignore accretion (=1)	(4) Ignore accretion (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.12***			-0.11**
	(0.05)			(0.04)
Conspiracy (1-5)	-0.01			-0.00
	(0.04)			(0.04)
Knowledge (0-10)	0.02*			0.01
	(0.01)			(0.01)
Having to relocate (0-10)	0.01			0.01
	(0.01)			(0.01)
Information sources				
Media (PCA)		-0.03		-0.03
		(0.03)		(0.03)
Social network (PCA)		-0.02		-0.01
		(0.02)		(0.02)
Exposure				
Distance to urban center (10km)			-0.01	-0.02
			(0.03)	(0.03)
Land lost (=1)			-0.12*	-0.11
			(0.07)	(0.08)
Rebuild (=1)			0.20***	0.18**
			(0.07)	(0.07)
Constant	1.01***	0.63***	0.61***	0.95***
	(0.23)	(0.15)	(0.16)	(0.24)
Socioeconomics	yes	yes	yes	yes
Observations	183	183	183	183
Adjusted R-squared	0.08	0.06	0.09	0.11

Note: Table A.21 presents coefficients from ordinary least square estimations, where the dependent variable equals 1 if respondents stated that the accretion information should be ignored by Bangladeshis like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.22 Determinants of ignoring accretion information in Bangladesh (Probit)

VARIABLES	(1) Ignore accretion (=1)	(2) Ignore accretion (=1)	(3) Ignore accretion (=1)	(4) Ignore accretion (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.39***			-0.37**
	(0.14)			(0.14)
Conspiracy (1-5)	-0.02			-0.04
	(0.13)			(0.13)
Knowledge (0-10)	0.06*			0.04
	(0.03)			(0.04)
Having to relocate (0-10)	0.03			0.05
	(0.03)			(0.03)
Information sources				
Media (PCA)		-0.10		-0.10
		(0.09)		(0.09)
Social network (PCA)		-0.07		-0.06
		(0.07)		(0.07)
Exposure				
Distance to urban center (10km)			-0.02	-0.05
			(0.08)	(0.09)
Land lost (=1)			-0.41	-0.40
			(0.25)	(0.27)
Rebuild (=1)			0.66***	0.65**
			(0.24)	(0.25)
Constant	1.92**	0.69	0.63	1.77**
	(0.77)	(0.51)	(0.58)	(0.82)
Socioeconomics	yes	yes	yes	yes
Observations	183	183	183	183
Pseudo R-squared	0.11	0.08	0.11	0.16

Notes: Table A.22 presents coefficient estimates from linear probability models of the outcome variable that equals 1 if respondents stated that the accretion information should be ignored by Bangladeshis like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.23 Determinants of the strength of ignoring the accretion information in Bangladesh (OLS)

VARIABLES	(1) Ignore accretion (0-5)	(2) Ignore accretion (0-5)	(3) Ignore accretion (0-5)	(4) Ignore accretion (0-5)
Climate change beliefs				
CC will get worse (1-5)	-0.26			-0.22
	(0.16)			(0.16)
Conspiracy (1-5)	0.17			0.14
	(0.17)			(0.18)
Knowledge (0-10)	0.04			0.02
	(0.04)			(0.04)
Having to relocate (0-10)	0.01			0.02
	(0.04)			(0.04)
Information sources				
Media (PCA)		-0.03		-0.03
		(0.12)		(0.11)
Social network (PCA)		-0.25***		-0.22***
		(0.08)		(0.08)
Exposure				
Distance to urban center (10km)			-0.07	-0.11
			(0.10)	(0.10)
Land lost (=1)			-0.28	-0.19
			(0.28)	(0.31)
Rebuild (=1)			0.65**	0.54**

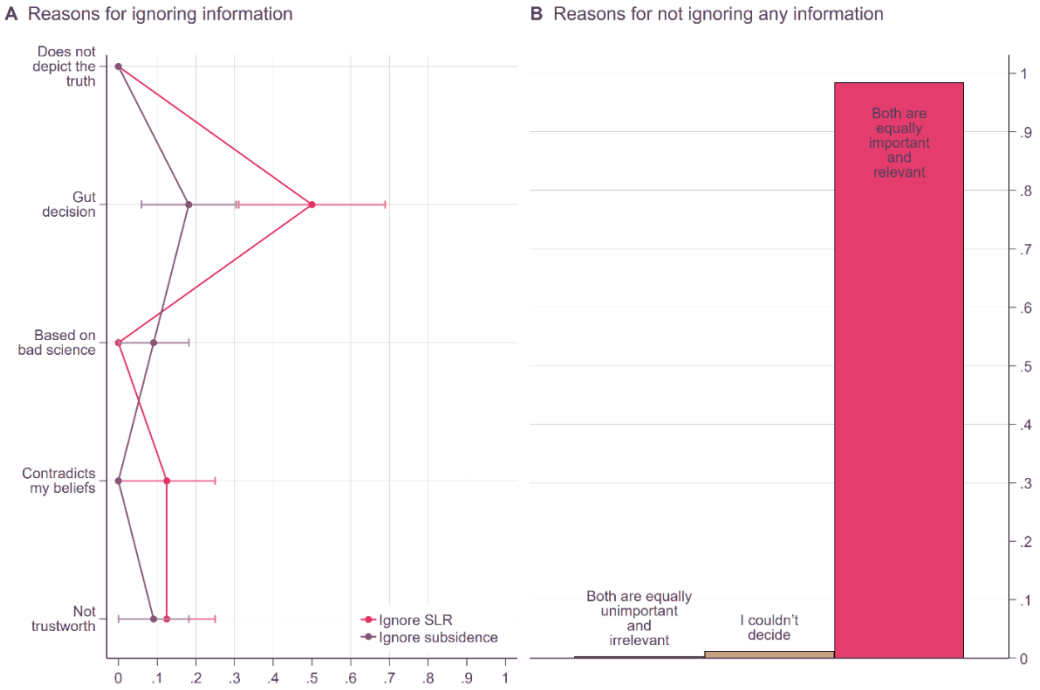
			(0.27)	(0.27)
Constant	2.75***	2.15***	2.17***	2.64***
	(0.81)	(0.51)	(0.58)	(0.84)
Socioeconomics	yes	yes	yes	yes
Observations	183	183	183	183
Adjusted R-squared	0.05	0.09	0.07	0.10

Note: Table A.23 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Bangladeshis like themselves. The outcome variable ranges from 0 "no information should be ignored" to 5 "the accretion information should be completely ignored." All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

A.2.4 Study 4: Vietnam

A.2.4.1 Reasons

Fig. A.8 Reasons stated for (not) ignoring information in Vietnam



Notes: Fig. A.8 shows the reasons stated by respondents in Vietnam for why the information should or should not be ignored. Panel A presents average values and 95% confidence intervals for respondents stating that the SLR information or the land subsidence information should be ignored. Panel B shows respondents' main reasons for stating that no information should be ignored.

A.2.4.2 Empirical evidence & robustness checks

Table A.24 Determinants of ignoring SLR risks in Vietnam (OLS)

VARIABLES	(1) Ignore SLR risks (=1)	(2) Ignore SLR risks (=1)	(3) Ignore SLR risks (=1)	(4) Ignore SLR risks (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.01			0.01
	(0.01)			(0.02)
Conspiracy (1-5)	-0.01			-0.01
	(0.02)			(0.02)

Knowledge (0-10)	0.01**			0.01*
	(0.01)			(0.01)
Having to relocate (0-10)	-0.00			-0.00
	(0.00)			(0.00)
Information sources				
Media (PCA)		0.04***		0.04***
		(0.01)		(0.01)
Social network (PCA)		-0.02***		-0.03***
		(0.01)		(0.01)
Exposure				
Distance to urban center (10km)			-0.00	-0.00
			(0.01)	(0.01)
Land lost (=1)			0.01	0.01
			(0.04)	(0.04)
Rebuild (=1)			-0.05**	-0.02
			(0.02)	(0.03)
Constant	0.15	0.15*	0.17**	0.09
	(0.10)	(0.08)	(0.08)	(0.11)
Socioeconomics	yes	yes	yes	yes
Observations	350	350	350	350
Adjusted R-squared	0.01	0.05	0.00	0.04

Note: Table A.24 presents coefficients from ordinary least square estimations, where the dependent variable equals 1 if respondents stated that the SLR risk information should be ignored by Vietnamese like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.25 Determinants of ignoring SLR risks in Vietnam (Probit)

VARIABLES	(1) Ignore SLR risks (=1)	(2) Ignore SLR risks (=1)	(3) Ignore SLR risks (=1)	(4) Ignore SLR risks (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.08			0.18
	(0.12)			(0.15)
Conspiracy (1-5)	-			
Knowledge (0-10)	0.09**			0.08*
	(0.04)			(0.05)
Having to relocate (0-10)	-0.04			-0.02
	(0.03)			(0.03)
Information sources				
Media (PCA)		0.30***		0.29***
		(0.10)		(0.10)
Social network (PCA)		-0.18***		-0.21***
		(0.06)		(0.08)
Exposure				
Distance to urban center (10km)			-0.03	-0.00
			(0.04)	(0.05)
Land lost (=1)			0.06	0.03
			(0.33)	(0.33)
Rebuild (=1)			-0.48	-0.24
			(0.32)	(0.33)
Constant	-0.82	-0.95*	-0.75	-2.00**
	(0.74)	(0.54)	(0.54)	(0.97)
Socioeconomics	yes	yes	yes	yes
Observations	329	350	350	350
Adjusted R-squared	0.06	0.12	0.04	0.15

Notes: Table A.25 presents coefficient estimates from linear probability models of the outcome variable that equals 1 if respondents stated that the SLR risk information should be ignored by Vietnamese like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

In Table A.25 column 1, the belief in climate change conspiracy theories is omitted, because there is no variation. All respondents who state that the SLR risk information should be ignored do not believe in any climate change conspiracy theory, that is all 26 respondents selected a value of 1 on the 5-point Likert scale. Therefore, we exclude the climate change conspiracy variable in the final model in column 4.

Table A.26 Determinants of the strength of ignoring SLR risk information in Vietnam (OLS)

VARIABLES	(1) Ignore SLR risks (0-5)	(2) Ignore SLR risks (0-5)	(3) Ignore SLR risks (0-5)	(4) Ignore SLR risks (0-5)
Climate change beliefs				
CC will get worse (1-5)	0.01			0.04
	(0.02)			(0.03)
Conspiracy (1-5)	-0.03			-0.04
	(0.03)			(0.04)
Knowledge (0-10)	0.01			0.01
	(0.01)			(0.01)
Having to relocate (0-10)	-0.00			0.00
	(0.01)			(0.01)
Information sources				
Media (PCA)		0.06**		0.05*
		(0.03)		(0.03)
Social network (PCA)		-0.03**		-0.03**
		(0.01)		(0.01)
Exposure				
Distance to urban center (10km)			0.00	0.01
			(0.01)	(0.01)
Land lost (=1)			-0.03	-0.03
			(0.05)	(0.05)
Rebuild (=1)			-0.09***	-0.05
			(0.03)	(0.04)
Constant	0.26	0.29*	0.30*	0.13
	(0.20)	(0.17)	(0.18)	(0.22)
Socioeconomics	yes	yes	yes	yes
Observations	350	350	350	350
Adjusted R-squared	-0.01	0.02	-0.00	0.01

Note: Table A.26 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Vietnamese like themselves. The outcome variable ranges from 0 “no information should be ignored” to 5 “the SLR risk information should be completely ignored.” All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.27 Determinants of ignoring land subsidence risks in Vietnam (OLS)

VARIABLES	(1) Ignore land subsidence (=1)	(2) Ignore land subsidence (=1)	(3) Ignore land subsidence (=1)	(4) Ignore land subsidence (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.02			-0.02
	(0.02)			(0.02)
Conspiracy (1-5)	-0.02			-0.03
	(0.01)			(0.02)
Knowledge (0-10)	0.00			-0.00
	(0.00)			(0.00)
Having to relocate (0-10)	-0.00			-0.01
	(0.00)			(0.00)
Information sources				
Media (PCA)		0.00		0.01

		(0.01)		(0.01)
Social network (PCA)		0.01		0.01
		(0.01)		(0.01)
Exposure				
Distance to urban center (10km)			0.01***	0.01***
			(0.00)	(0.00)
Land lost (=1)			0.07	0.08
			(0.05)	(0.05)
Rebuild (=1)			0.05*	0.07**
			(0.03)	(0.03)
Constant	0.29***	0.20***	0.14**	0.29***
	(0.10)	(0.06)	(0.06)	(0.09)
Socioeconomics	yes	yes	yes	yes
Observations	340	340	340	340
Adjusted R-squared	0.02	0.02	0.06	0.06

Note: Table A.27 presents coefficients from ordinary least square estimations, where the dependent variable equals 1 if respondents stated that the land subsidence information should be ignored by Vietnamese like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A.28 Determinants of ignoring land subsidence risks in Vietnam (Probit)

VARIABLES	(1) Ignore land subsidence (=1)	(2) Ignore land subsidence (=1)	(3) Ignore land subsidence (=1)	(4) Ignore land subsidence (=1)
Climate change beliefs				
CC will get worse (1-5)	-0.23			-0.26
	(0.15)			(0.16)
Conspiracy (1-5)	-			
Knowledge (0-10)	0.04			0.01
	(0.05)			(0.04)
Having to relocate (0-10)	-0.03			-0.06
	(0.04)			(0.05)
Information sources				
Media (PCA)		0.02		0.14
		(0.11)		(0.13)
Social network (PCA)		0.09		0.09
		(0.09)		(0.09)
Exposure				
Distance to urban center (10km)			0.15***	0.14***
			(0.05)	(0.04)
Land lost (=1)			0.51*	0.66**
			(0.29)	(0.30)
Rebuild (=1)			0.45*	0.53*
			(0.26)	(0.29)
Constant	0.99	0.15	-0.48	0.57
	(0.78)	(0.54)	(0.70)	(0.71)
Socioeconomics	yes	yes	yes	yes
Observations	319	340	340	340
Adjusted R-squared	0.12	0.10	0.20	0.24

Notes: Table A.28 presents coefficient estimates from linear probability models of the outcome variable that equals 1 if respondents stated that the land subsidence information should be ignored by Vietnamese like themselves and 0 if no information should be ignored. All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Robust standard errors are presented in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

In Table A.28 column 1, the belief in climate change conspiracy theories is omitted, because there is no variation. All respondents who state that the land subsidence

information should be ignored do not believe in any climate change conspiracy theory, that is all 16 respondents selected a value of 1 on the 5-point Likert scale. Therefore, we exclude the climate change conspiracy variable in the final model in column 4.

Table A.29 Determinants of the strength of ignoring land subsidence risks in Vietnam (OLS)

VARIABLES	(1) Ignore SLR risks (0-5)	(2) Ignore SLR risks (0-5)	(3) Ignore SLR risks (0-5)	(4) Ignore SLR risks (0-5)
Climate change beliefs				
CC will get worse (1-5)	-0.05			-0.06
	(0.05)			(0.04)
Conspiracy (1-5)	-0.06*			-0.10*
	(0.03)			(0.06)
Knowledge (0-10)	0.00			-0.01
	(0.01)			(0.01)
Having to relocate (0-10)	-0.01			-0.01
	(0.01)			(0.01)
Information sources				
Media (PCA)		-0.00		0.04
		(0.02)		(0.03)
Social network (PCA)		0.02		0.01
		(0.03)		(0.02)
Exposure				
Distance to urban center (10km)			0.04***	0.04***
			(0.01)	(0.01)
Land lost (=1)			0.29*	0.34**
			(0.16)	(0.17)
Rebuild (=1)			0.17*	0.22**
			(0.10)	(0.11)
Constant	0.84***	0.60***	0.43***	0.83***
	(0.30)	(0.19)	(0.16)	(0.28)
Socioeconomics	yes	yes	yes	yes
Observations	340	340	340	340
Adjusted R-squared	0.01	0.01	0.07	0.07

Note: Table A.29 presents coefficients from ordinary least square estimations, where the dependent variable is the degree to which respondents stated that the information should be ignored by Vietnamese like themselves. The outcome variable ranges from 0 “no information should be ignored” to 5 “the land subsidence information should be completely ignored.” All regression (1) – (4) control for respondents' age, gender, years of education, and household income per person. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

A.3 Study materials

Fig. A. 9 Item measuring motivated reasoning in the U.S. survey

Considering both videos on sea-level rise (SLR), which one (if any) do you think Americans like you should ignore?

Please indicate your opinion using the following scale

'5' on the very left means that Americans like you should completely ignore the video suggesting that **sea-level rise (SLR) is not a major threat to the U.S.** because it does not contain any valuable information at all.

'5' on the very right means that Americans like you should completely ignore the video suggesting that **sea-level rise (SLR) is a major threat to the U.S.** because it does not contain any valuable information at all.

'0' in the middle means that neither videos should be ignored.

Ignore video suggesting SLR is not a major threat to the U.S.	Ignore neither										Ignore video suggesting SLR is major threat to the U.S.
	○	○	○	○	○	○	○	○	○	○	○

Next

Matthias Mayer, Philipps-University Marburg – 2020

B. Chapter 3: Supplementary material

The supplementary materials for chapter 3 are organized as follows: Section B1 provides summary statistics, balancing across groups and information on affectedness across groups. Section B2 shows how respondents perceive past and future climate change impacts and their recommendation on how best to adapt to rising sea-levels. Section B3 provides the complete regression tables behind the graphical visualizations, model extensions, and robustness checks. In section B4, the reader can find additional information on migration aspirations and a descriptive analysis of the financial feasibility to act on these aspirations.

B.1 Summary statistics, descriptive results, affectedness, and balancing across groups

Supplementary Table B.1 gives an overview of the different outcome variables and non-standardized independent variables used in the analysis presented in the main manuscript. Table B.2 shows the self-reported damages by hazards and perceived risks of SLR across the three groups, while Table B.3 shows the balancing of socioeconomic variables between the groups.

Table B.1 Summary statistics

Panel A: Outcomes	N	Mean	SD	Min	Max
Preferences					
Stair-case Risk: Bangladesh	247	24.18	12.67	1	32
Investment Task: Vietnam	377	10,068.97	7,635.34	0	20000
Place identity (6, 30)	624	26.46	3.99	8	30
Place dependence (6, 30)	624	22.56	4.46	7	30
Migration Aspirations					
No aspiration (=1)	623	0.38	0.49	0	1
Low-income destination (=1)	623	0.04	0.20	0	1
Medium-income destination (=1)	623	0.16	0.36	0	1
High-income destination (=1)	623	0.42	0.49	0	1
Migration likelihood (very unlikely)	385	0.71	0.45	0	1
Migration likelihood (neither unlikely nor likely)	385	0.22	0.42	0	1
Migration likelihood (very likely)	385	0.06	0.25	0	1
Panel B: Explanatory variables					
Affectedness					
Number of droughts, floods & storms in the last 5 years	624	2.73	3.44	0	40
Damages & perceived threat					
Number of times rebuild house	624	0.88	2.28	0	15
Rebuild days	624	11.39	43.66	0	730
Rebuild costs (PPP adjusted)	617	1,464.70	4,623.37	0	43085
Relocation due to floods or land erosion in the past 10 years (=1)	624	0.38	0.48	0	1
Having lost land (=1)	624	0.22	0.41	0	1
Perceived threat of SLR for livelihoods	624	7.37	3.01	0	10
Perceived threat of SLR for relocation	624	3.67	3.50	0	10
Perceived intensity of future SLR impacts	624	3.84	1.05	1	5
Socio-economics					
Female (=1)	624	0.55	0.50	0	1

Age	624	40.79	14.25	18	92
Education (years)	624	6.83	4.43	0	18
Household size	624	4.42	1.64	1	12
Married (=1)	624	0.79	0.41	0	1
Value assets (PPP adjusted)	613	39,159.81	96,312.16	0	1470736
Monthly household income (PPP adjusted)	622	1,224.85	2,945.04	0	53856

Notes: All cost, income and asset value data has been PPP adjusted using conversion factors from the time of data collection.

Table B.2 Affectedness across self-reported hazards

	(1)	(2)	(3)		
	None	1 or 2	3 or more	T-test differences	
VARIABLES	Mean/SD	Mean/SD	Mean/SD	(1)-(2)	(1)-(3)
House: Rebuild frequency due to disasters	0.61	1.00	0.90	-0.40*	-0.29
	[1.62]	[2.49]	[2.31]		
House: Rebuild days after disaster	8.03	12.80	12.53	-4.77	-4.50
	[32.89]	[33.88]	[56.15]		
House: Rebuild costs after disaster	786.20	2250.52	1267.54	-1464.33***	-481.34
	[2752.03]	[6297.64]	[3827.87]		
Relocate due to disaster (=1)	0.27	0.50	0.57	-0.23***	-0.31***
	[0.44]	[0.50]	[0.50]		
Lost land to erosion (=1)	0.23	0.19	0.24	0.03	-0.01
	[0.42]	[0.40]	[0.43]		
Perceived threat to livelihoods due to disasters	6.51	6.95	8.33	-0.44	-1.83***
	[3.42]	[2.90]	[2.49]		
Perceived relocation risk due to disasters	2.71	3.55	4.47	-0.84**	-1.76***
	[3.19]	[3.50]	[3.53]		
Future perception of SLR impacts	3.72	3.73	4.02	-0.01	-0.30***
	[1.04]	[1.07]	[1.03]		
Observations	171	211	242		
F-test of joint significance (F-stat)				4.70***	11.74***
F-test, number of observations				377	410

Notes: *** p<0.01, ** p<0.05, * p<0.1

Table B.3 Balancing across self-reported hazards

	(1)	(2)	(3)		
	None	1 or 2	3 or more	T-test differences	
VARIABLES	Mean/SD	Mean/SD	Mean/SD	(1)-(2)	(1)-(3)
Female	0.50	0.57	0.57	-0.07	-0.06
	[0.50]	[0.50]	[0.50]		
Age(years)	40.49	40.32	41.41	0.17	-0.92
	[14.00]	[14.71]	[14.05]		
Education (years)	6.91	6.35	7.21	0.57	-0.29
	[4.56]	[4.37]	[4.37]		
Household size	4.50	4.61	4.19	-0.11	0.31*
	[1.75]	[1.52]	[1.65]		
Married	0.83	0.76	0.79	0.07*	0.05
	[0.38]	[0.43]	[0.41]		
Monthly HH income (PPP)	931.95	1267.36	1394.24	-335.41	-462.29**
	[1100.61]	[4217.79]	[2435.56]		
Value assets (PPP)	38572.65	39406.14	39353.68	-833.49	-781.03
	[68212.22]	[125875.66]	[83190.64]		
Observations	171	206	242		
F-test (F-stat)				1.17	2.33**
F-test (obs)				371	405

Notes: *** p<0.01, ** p<0.05, * p<0.1

Table B.4 Determinants of number of self-reported hazards

VARIABLES	(1) Number of reported hazards
Female	0.18
	(0.30)
Age(years)	0.01
	(0.01)
Education (years)	-0.01
	(0.03)
Household size	-0.24
	(0.36)
Married	-0.04
	(0.08)
Monthly HH income (PPP)	0.48***
	(0.12)
Value assets (PPP)	0.02
	(0.07)
Constant	-0.54
	(1.02)
Observations	611
Adjusted R-squared	0.01

Notes: *** p<0.01, ** p<0.05, * p<0.1

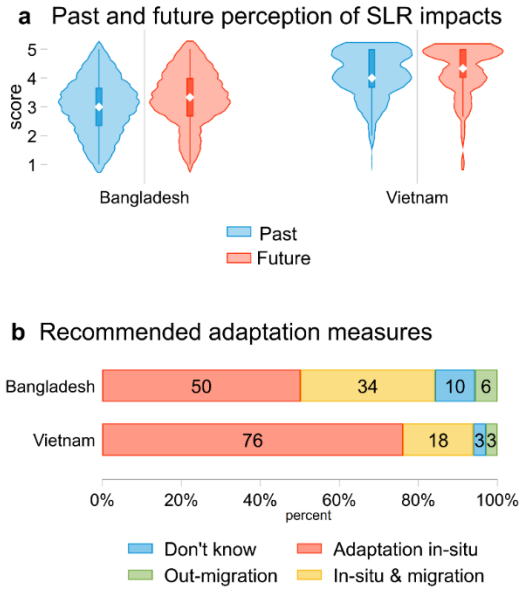
B.2 Impact- and risk appraisal of SLR hazards and adaptation strategies

We find evidence that respondents are indeed highly aware of sea-level rise impacts (higher, salinization and erosion) and that these will become worse in the future (paired T-test n = 624, diff. (past-future) = -.21, p = .00, see Fig. B.1A). Respondents in Bangladesh perceive SLR impacts as less likely to happen compared to respondents in Vietnam (Mann-Whitney U-Test, z = -11.17, p = .00). On average, respondents in Bangladesh and Vietnam perceive that floods and erosion will be a severe threat to their livelihoods ($Mean_{Bangladesh}$ = 7.01±2.80, $Mean_{Vietnam}$ = 7.60±3.12). 11% (n = 70) of respondents already believe it is "absolutely certain" that they will have to move permanently to a different place because of these impacts.

We derive adaptation responses from a hypothetical scenario of a two-foot (61 cm) rise in sea-level within the next five years (Fig. B.1B). We explicitly asked respondents what they would recommend to others not what they would do themselves. This allows us to avoid biases related to self-reported behavioral intentions and enables respondents to express their preferences for different adaptation measures without being affected by their personal (lack of) capacities. In line with other studies, we find that most people would recommend in-situ adaptation to SLR despite respondents being aware of the potential impacts and risks. Mobility is predominantly seen as a last resort if all other adaptation measures fail. Overall, there seems to be a strong preference for known collective in-situ adaptation measures, the majority with 66% (n = 411) recommends these measures, ranging between 50% in Bangladesh and 76% in Vietnam. The most preferred in-situ adaptation measures are by far sea-walls, named by 69% of respondents, followed by planting mangroves

(50%), moving within the community boundaries (32%) and beach nourishment measures that try to counteract erosion (24%). The second most mentioned strategy with 24% of respondents is a combination of both in-situ adaptation as long as possible before moving away. Given that SLR impacts accumulate slowly over the years, these measures might be perceived as sufficient for now, leading people to overestimate their efficacy in dealing with them. Only 4% of respondents see migration as the only option to adapt and 6% of respondents would not know what to do at all.

Fig. B.1 Perceived climate impacts and recommended adaptation actions



Notes: The white diamond indicates the median; the blue box shows the interquartile range (middle 50% of values) and the light blue area shows the rotated and smoothed density plot. Panel A shows the distribution of the past and future SLR impact appraisal index (1 to 5). Higher values imply stronger agreement that sea levels are or will be higher, saltwater intrusion and coastal erosion already happened or will happen. Panel B shows the results from an open-ended question where respondents could give multiple answers based on which respondents were classified into four distinct categories: (i) people who didn't mention any measures, (ii) only in-situ adaptation measures; (iii) only out-migration and (iv) a combination of in-situ adaptation and out-migration. We asked respondents what they would recommend to people living in low-lying coastal areas or atolls to do to prepare themselves. "Suppose sea levels will increase by 1/2 meter within the next five years. This would mean that waves become much stronger, more land will be lost to the sea, and saltwater will come further into the land on high tides."

B.3 Additional analysis and robustness checks

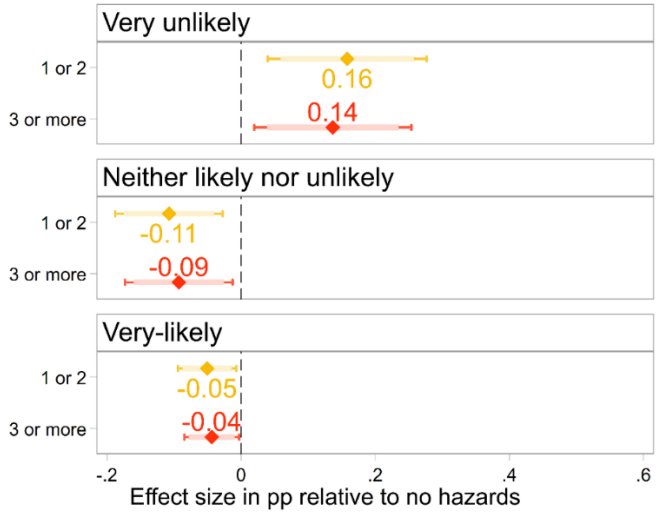
B.3.1 Migration likelihood in the next three years

We study migration in a sample where people are (i) highly affected by hazards related to rising sea-levels and (ii) many desire to move internationally but have low ability to act on these aspirations potentially worsened by climate hazards. Overall, 71% of respondents with an aspiration assessed it as "very unlikely" (n = 274), while only 6% are optimistic (n=25) to move abroad. The other 22% (n = 86) perceive their chances as neither "very likely" nor "very unlikely". Indeed, when predicting the migration likelihood, we find that number of reported climate hazards are associated with a lower likelihood to act on aspirations to move abroad within the next three years (see Fig. B.2). In the Supplementary

Section B.4, we further investigated respondent's financial ability to act on their aspirations. This descriptive analysis revealed that only three respondents who assessed their likelihood as "very likely" could move to their desired destination (South Africa, Australia, Thailand) given their financial ability.

Thus, while climate hazards are associated with aspiring to move abroad, they are negatively correlated with the likelihood to act on these aspirations. This could be in line with our proposed conceptual model where people are more likely to form aspirations beyond their capacities (high-income destinations) with increasing hazards neglecting less attractive alternatives, which may ultimately result in more people staying in hazardous environments.

Fig. B.2 Predicted migration likelihood in the next three years



Notes: Predicted estimates from an ordered logistic regression of reported hazards on the likelihood to act on their migration aspirations within the next three years. In all models we include village fixed effects and control for socio-economics and damages. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

B.3.2 Robustness checks of main results

In the following we provide the full regression outputs underlying the results presented in the figures showing estimates for all control variables (Table B.5 & Table B.6). In addition, we provide several robustness checks that raise our confidence regarding the findings shown in the main manuscript:

- Country specific analysis yield similar results, even when controlling for interviewer fixed effects (Table B.7 to Table B.9)
- Binary specification of risk aversion due to clustering at the extremes yields similar results in Bangladesh (Table B.12)
- Results for place attachment are robust when accounting for the correlation between both place attachment dimensions using SURE models (Table B.12)
- Results on risk attitudes and place attachment are robust when using tobit models to account for censoring of the data (Table B.11) and the count structure of the data (Table B.12)
- Results are also robust when using a binary explanatory variable of reported hazards Table B.13 or aggregate measure (Table B.14) and when excluding respondents who moved recently to the village where we interviewed them, as these might have had less time to experience hazards at this place (Table B.15).

Table B.5 Full regression output for preferences (Fig. 3.3A)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Risk (z-score)		Identity (z-score)		Dependance (z-score)	
Hazards: 1 or 2	0.14	0.20*	0.22**	0.19*	0.30***	0.26**
	(0.11)	(0.11)	(0.11)	(0.11)	(0.10)	(0.10)
Hazards: 3 or more	0.17*	0.23**	0.31***	0.29***	0.05	0.06
	(0.10)	(0.10)	(0.11)	(0.11)	(0.10)	(0.11)
Socio-economics						
Female (=1)		0.12		-0.12		-0.04
		(0.08)		(0.09)		(0.09)
Age (years)		0.01**		0.01		0.01***
		(0.00)		(0.00)		(0.00)
Married (=1)		-0.09		-0.10		0.25**
		(0.10)		(0.11)		(0.12)
Education		-0.00		0.01		-0.01
		(0.01)		(0.01)		(0.01)
Household size		-0.07		0.05		-0.03
		(0.05)		(0.05)		(0.05)
HH monthly income (log+1)		0.01		-0.01		-0.02
		(0.03)		(0.03)		(0.03)
HH asset value (log+1)		-0.01		0.03		0.05*
		(0.03)		(0.02)		(0.03)
Damages by hazards						
Land lost erosion (=1)		-0.07		0.04		-0.15
		(0.11)		(0.10)		(0.12)
House rebuild index (PCA)		-0.06**		0.01		0.00
		(0.03)		(0.03)		(0.03)
Constant	0.28	0.44	-0.15	-0.58	-0.02	-0.31
	(0.18)	(0.38)	(0.13)	(0.44)	(0.16)	(0.42)

Village FE	Y	Y	Y	Y	Y	Y
Observations	624	605	624	605	624	605
Adjusted / Pseudo R-squared	0.09	0.10	0.02	0.01	0.02	0.06
F-test: Socio-economics		0.09		0.22		0.00
F-test: Damages		0.05		0.85		0.43

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.6 Multinomial logit with no aspiration as the reference group (Fig. 3.3B)

VARIABLES	(1) No aspiration (refrerence group)	(2) Low income	(3) Medium income	(4) High income
Hazards: 1 or 2		1.26**	0.92**	0.37
		(0.60)	(0.43)	(0.29)
Hazards: 3 or more		0.71	1.68***	0.98***
		(0.67)	(0.46)	(0.29)
Socio-economics				
Female (=1)		1.10*	0.30	0.27
		(0.64)	(0.37)	(0.22)
Age (years)		-0.01	-0.02	-0.02*
		(0.02)	(0.02)	(0.01)
Married (=1)		-0.68	-0.64	0.11
		(0.78)	(0.48)	(0.27)
Education		0.01	-0.05	0.08**
		(0.07)	(0.05)	(0.03)
Household size		-0.11	-0.25**	-0.05
		(0.14)	(0.12)	(0.09)
HH monthly income (log+1)		0.61**	0.51***	0.50***
		(0.28)	(0.18)	(0.17)
HH asset value (log+1)		0.25	-0.09	0.11
		(0.19)	(0.12)	(0.09)
Damages by hazards				
Land lost erosion (=1)		-0.08	0.43	-0.23
		(0.66)	(0.44)	(0.31)
House rebuild index (PCA)		-0.16	-0.10	0.03
		(0.17)	(0.12)	(0.08)
Constant		-5.14**	1.11	-2.38*
		(2.33)	(1.57)	(1.36)
Village FE		Y	Y	Y
Observations	605	605	605	605
Pseudo-squared	0.33	0.33	0.33	0.33

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.7 Additional regressions: risk preferences

	Pooled Risk (z-score)			BD Staircase (1 - 32)	VN Amount invested
VARIABLES	(1)	(2)	(3)	(4)	(5)
Hazards: 1 or 2	0.14	0.21**	0.27**	3.94*	-2,155.62
	(0.11)	(0.11)	(0.12)	(2.19)	(1,361.03)
Hazards: 3 or more	0.17*	0.24**	0.45***	4.45**	-4,491.38***
	(0.10)	(0.10)	(0.12)	(2.26)	(1,403.17)
Socio-economics					
Female (=1)		0.14	0.10	0.10	-1,350.23
		(0.09)	(0.09)	(2.11)	(852.59)
Age (31-40)		0.17	0.21*	0.95	-2,933.32**
		(0.12)	(0.11)	(2.15)	(1,324.71)
Age (41-50)		0.14	0.15	1.45	-2,115.27
		(0.13)	(0.13)	(2.65)	(1,473.77)
Age (51-60)		0.46***	0.47***	3.39	-4,944.02***
		(0.15)	(0.15)	(3.63)	(1,548.15)
Age (>60)		0.27*	0.22	-1.72	-2,905.73*

		(0.16)	(0.16)	(6.38)	(1,599.38)
Married (=1)		-0.11	-0.16	-1.40	1,155.00
		(0.10)	(0.11)	(2.46)	(1,062.52)
Education		-0.00	-0.01	-0.07	15.37
		(0.01)	(0.01)	(0.22)	(122.39)
Household size		-0.02	-0.01	-0.83	-468.38
		(0.03)	(0.03)	(0.51)	(294.55)
HH monthly income (log+1)		-0.07	-0.02	0.44	650.07
		(0.05)	(0.05)	(0.83)	(698.62)
HH asset value (log+1)		0.01	0.02	0.15	-195.73
		(0.03)	(0.03)	(0.54)	(265.47)
Damages extremes					
Land lost erosion (=1)		-0.07	-0.06	-2.63	-1,060.43
		(0.11)	(0.11)	(1.90)	(1,250.94)
House rebuild index (PCA)		-0.06**	-0.06**	-1.09*	395.95
		(0.03)	(0.03)	(0.61)	(341.25)
Constant	0.28	0.62*	-0.16	21.00***	14,905.82***
	(0.18)	(0.36)	(0.42)	(7.93)	(4,760.43)
Village FE	Y	Y	Y	Y	Y
Interviewer FE	N	N	Y	Y	Y
Observations	624	605	604	247	357
Adjusted R-squared	0.09	0.10	0.14	0.05	0.08

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.8 Additional regressions: place identity (z-score)

		Pooled		Bangladesh	Vietnam
VARIABLES	(1)	(2)	(3)	(4)	(5)
Hazards: 1 or 2	0.22**	0.20*	0.12	0.00	0.45**
	(0.11)	(0.11)	(0.12)	(0.13)	(0.17)
Hazards: 3 or more	0.31***	0.29***	0.19	-0.04	0.60***
	(0.11)	(0.11)	(0.12)	(0.14)	(0.17)
Socio-economics					
Female (=1)		-0.13	-0.08	-0.31***	0.00
		(0.09)	(0.08)	(0.12)	(0.12)
Age (31-40)		0.00	-0.02	-0.13	0.11
		(0.12)	(0.11)	(0.15)	(0.19)
Age (41-50)		0.25**	0.14	0.05	0.41**
		(0.12)	(0.12)	(0.15)	(0.20)
Age (51-60)		0.05	0.04	-0.04	0.15
		(0.15)	(0.15)	(0.17)	(0.22)
Age (>60)		0.22	0.18	0.09	0.35
		(0.16)	(0.15)	(0.24)	(0.22)
Married (=1)		-0.09	0.04	0.12	-0.18
		(0.12)	(0.12)	(0.16)	(0.16)
Education		0.01	-0.01	0.01	0.00
		(0.01)	(0.01)	(0.01)	(0.02)
Household size		0.04	0.04	0.00	0.09**
		(0.02)	(0.02)	(0.03)	(0.04)
HH monthly income (log+1)		0.05	0.10*	0.01	0.10
		(0.05)	(0.05)	(0.06)	(0.09)
HH asset value (log+1)		-0.01	0.02	-0.00	-0.03
		(0.03)	(0.03)	(0.04)	(0.06)
Damages extremes					
Land lost erosion (=1)		0.05	-0.03	0.06	-0.01
		(0.10)	(0.09)	(0.12)	(0.16)
House rebuild index (PCA)		0.00	-0.02	-0.00	0.02
		(0.03)	(0.03)	(0.03)	(0.04)
Constant	-0.15	-0.45	-1.38***	0.09	-1.17
	(0.13)	(0.42)	(0.47)	(0.48)	(0.72)
Village FE	Y	Y	Y	Y	Y
Interviewer FE	N	N	Y	N	N
Observations	624	605	604	247	358
Adjusted R-squared	0.02	0.02	0.19	-0.02	0.04

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.9 Additional regressions: place dependence (z-score)

VARIABLES	(1)	Pooled (2)	(3)	Bangladesh (4)	Vietnam (5)
Hazards: 1 or 2	0.30***	0.27**	0.15	0.21	0.42***
	(0.10)	(0.10)	(0.11)	(0.14)	(0.16)
Hazards: 3 or more	0.05	0.06	0.07	0.05	0.18
	(0.10)	(0.11)	(0.12)	(0.15)	(0.15)
Socio-economics					
Female (=1)		-0.04	-0.05	-0.05	-0.03
		(0.09)	(0.09)	(0.13)	(0.11)
Age (31-40)		0.05	0.04	-0.13	0.32*
		(0.12)	(0.11)	(0.15)	(0.19)
Age (41-50)		0.22	0.17	-0.03	0.52**
		(0.14)	(0.14)	(0.17)	(0.23)
Age (51-60)		0.26*	0.22	0.19	0.45**
		(0.15)	(0.15)	(0.23)	(0.22)
Age (>60)		0.46***	0.37**	0.75***	0.65***
		(0.17)	(0.17)	(0.26)	(0.23)
Married (=1)		0.29**	0.34***	0.13	0.33**
		(0.12)	(0.12)	(0.18)	(0.16)
Education		-0.01	-0.02**	-0.00	-0.02
		(0.01)	(0.01)	(0.02)	(0.02)
Household size		0.05**	0.04	-0.01	0.13***
		(0.03)	(0.03)	(0.03)	(0.04)
HH monthly income (log+1)		-0.03	0.03	-0.09	-0.01
		(0.05)	(0.06)	(0.07)	(0.08)
HH asset value (log+1)		-0.01	0.00	-0.02	-0.02
		(0.03)	(0.03)	(0.03)	(0.04)
Damages extremes					
Land lost erosion (=1)		-0.14	-0.12	0.04	-0.31*
		(0.12)	(0.11)	(0.15)	(0.18)
House rebuild index (PCA)		0.00	-0.02	-0.00	0.02
		(0.03)	(0.03)	(0.04)	(0.03)
Constant	-0.02	-0.10	-0.82*	0.72	-0.82
	(0.16)	(0.39)	(0.48)	(0.51)	(0.61)
Village FE	Y	Y	Y	Y	Y
Interviewer FE	N	N	Y	N	N
Observations	624	605	604	247	358
Adjusted R-squared	0.02	0.06	0.12	-0.02	0.11

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.10 SURE models place attachment

VARIABLES	Identity (1)	Dependence (2)
Hazards: 1 or 2	0.20*	0.27***
	(0.10)	(0.10)
Hazards: 3 or more	0.29***	0.06
	(0.10)	(0.10)
Socio-economics		
Female (=1)	-0.13	-0.04
	(0.09)	(0.08)
Age (31-40)	0.00	0.05
	(0.12)	(0.11)
Age (41-50)	0.25*	0.22*
	(0.13)	(0.13)
Age (51-60)	0.05	0.26*
	(0.15)	(0.15)
Age (>60)	0.22	0.46***
	(0.16)	(0.16)
Married (=1)	-0.09	0.29***
	(0.11)	(0.11)

Education	0.01	-0.01
	(0.01)	(0.01)
Household size	0.04	0.05**
	(0.03)	(0.03)
HH monthly income (log+1)	0.05	-0.03
	(0.05)	(0.05)
HH asset value (log+1)	-0.01	-0.01
	(0.03)	(0.03)
Damages extremes		
Land lost erosion (=1)	0.05	-0.14
	(0.11)	(0.11)
House rebuild index (PCA)	0.00	0.00
	(0.03)	(0.03)
Constant	-0.45	-0.10
	(0.38)	(0.37)
Observations	605	605
Adjusted R-squared	0.06	0.11

Notes: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.11 Tobit models: accounting for censoring of measures

VARIABLES	Risk (1)	Identity (2)	Dependence (3)
Hazards: 1 or 2	0.31**	0.03	0.05**
	(0.15)	(0.03)	(0.02)
Hazards: 3 or more	0.54***	0.07**	0.01
	(0.16)	(0.03)	(0.02)
Socio-economics			
Female (=1)	0.07	-0.02	-0.01
	(0.10)	(0.02)	(0.02)
Age (31-40)	0.27*	-0.00	0.01
	(0.14)	(0.03)	(0.02)
Age (41-50)	0.18	0.07**	0.04
	(0.16)	(0.03)	(0.03)
Age (51-60)	0.53***	0.01	0.05*
	(0.18)	(0.04)	(0.03)
Age (>60)	0.25	0.04	0.09***
	(0.19)	(0.04)	(0.03)
Married (=1)	-0.14	-0.03	0.06**
	(0.12)	(0.03)	(0.02)
Education	-0.01	0.00	-0.00
	(0.01)	(0.00)	(0.00)
Household size	-0.01	0.01	0.01*
	(0.03)	(0.01)	(0.01)
HH monthly income (log+1)	-0.01	0.01	-0.01
	(0.07)	(0.01)	(0.01)
HH asset value (log+1)	0.02	-0.01	-0.00
	(0.03)	(0.01)	(0.01)
Damages extremes			
Land lost erosion (=1)	-0.06	0.00	-0.02
	(0.13)	(0.02)	(0.02)
House rebuild index (PCA)	-0.08**	0.00	0.00
	(0.04)	(0.01)	(0.01)
Constant	0.52	0.83***	0.66***
	(0.51)	(0.11)	(0.08)
Village FE	Y	Y	Y
Interviewer FE	Y	N	N
Observations	604	605	605
Pseudo R-squared	0.12	0.11	-0.43

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.12 Accounting for count structure of measures

	Bangladesh: Risk staircase			Vietnam: Amount invested in risky lottery		Pooled: Poisson	
	Poisson	Negative-binomial	Probit	Poisson	Negative-binomial	Place identity	Place dependence
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hazards: 1 or 2	0.16*	0.18	0.12*	-0.22*	-0.25	0.04*	0.08**
	(0.09)	(0.11)	(0.07)	(0.13)	(0.17)	(0.02)	(0.03)
Hazards: 3 or more	0.19**	0.19*	0.15**	-0.47***	-0.54***	0.06***	0.02
	(0.09)	(0.12)	(0.07)	(0.14)	(0.19)	(0.02)	(0.03)
Socio-economics							
Female (=1)	0.01	0.04	-0.02	-0.14*	-0.15	-0.03	-0.01
	(0.08)	(0.11)	(0.06)	(0.08)	(0.11)	(0.02)	(0.02)
Age (31-40)	0.04	0.04	0.02	-0.28**	-0.38***	-0.00	0.01
	(0.09)	(0.11)	(0.06)	(0.12)	(0.14)	(0.03)	(0.03)
Age (41-50)	0.06	0.10	0.03	-0.21	-0.31*	0.05**	0.06
	(0.10)	(0.13)	(0.08)	(0.13)	(0.16)	(0.03)	(0.04)
Age (51-60)	0.14	0.12	0.12	-0.52***	-0.64***	0.01	0.08*
	(0.14)	(0.19)	(0.09)	(0.15)	(0.19)	(0.03)	(0.04)
Age (>60)	-0.06	0.02	-0.14	-0.29*	-0.40**	0.05	0.13***
	(0.23)	(0.25)	(0.23)	(0.15)	(0.19)	(0.03)	(0.05)
Married (=1)	-0.06	-0.12	-0.04	0.13	0.15	-0.02	0.09**
	(0.10)	(0.12)	(0.07)	(0.11)	(0.12)	(0.02)	(0.04)
Education	-0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Household size	-0.03	-0.04*	-0.03**	-0.05	-0.05	0.01	0.01**
	(0.02)	(0.03)	(0.01)	(0.03)	(0.04)	(0.01)	(0.01)
HH monthly income (log+1)	0.02	0.02	0.02	0.07	0.10	0.01	-0.01
	(0.03)	(0.04)	(0.03)	(0.07)	(0.08)	(0.01)	(0.01)
HH asset value (log+1)	0.00	0.01	0.00	-0.02	-0.03	-0.00	-0.00
	(0.02)	(0.03)	(0.02)	(0.03)	(0.04)	(0.01)	(0.01)
Damages extremes							
Land lost erosion (=1)	-0.12	-0.14	-0.10*	-0.11	-0.11	0.01	-0.04
	(0.08)	(0.10)	(0.06)	(0.14)	(0.15)	(0.02)	(0.03)
House rebuild index (PCA)	-0.04*	-0.06*	-0.03*	0.05	0.04	0.00	0.00
	(0.02)	(0.03)	(0.02)	(0.04)	(0.04)	(0.01)	(0.01)
Constant	3.05***	3.12***		9.56***	9.48***	-0.28***	-0.42***
	(0.32)	(0.42)		(0.49)	(0.57)	(0.09)	(0.11)
Village FE	Y	Y	Y	Y	Y	Y	Y
Interviewer FE	Y	Y	Y	Y	Y	N	N
Observations	247	247	247	357	357	605	605
Pseudo R-Squared	0.07	0.01	0.14	0.12	0.00	0.00	0.00

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.13 Binary specification of self-reported hazards variable (yes / no)

	Risk (z-score)	Identity (z-score)	Dependance (z-score)	Aspiration to move abroad (=1)
VARIABLES	(1)	(2)	(3)	(4)
Climate related hazard (=1)	0.28***	0.23**	0.21**	0.09**
	(0.10)	(0.11)	(0.10)	(0.04)
Number of hazards	-0.02	0.00	-0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Socio-economics				
Female (=1)	0.12	-0.12	-0.04	0.04
	(0.08)	(0.09)	(0.09)	(0.03)
Age (years)	0.01**	0.01	0.01***	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
Married (=1)	-0.09	-0.10	0.24**	0.01

	(0.10)	(0.11)	(0.12)	(0.04)
Education	-0.00	0.01	-0.02	0.01**
	(0.01)	(0.01)	(0.01)	(0.00)
Household size	-0.06	0.06	-0.04	0.08***
	(0.05)	(0.05)	(0.05)	(0.02)
HH monthly income (log+1)	0.01	-0.01	-0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.01)
HH asset value (log+1)	-0.01	0.03	0.05**	-0.02
	(0.03)	(0.02)	(0.03)	(0.01)
Damages extremes				
Land lost erosion (=1)	-0.06	0.05	-0.16	-0.01
	(0.11)	(0.10)	(0.12)	(0.05)
House rebuild index (PCA)	-0.06**	0.01	0.01	-0.00
	(0.03)	(0.03)	(0.03)	(0.01)
Constant	0.41	-0.60	-0.28	
	(0.38)	(0.44)	(0.42)	
Village FE	Y	Y	Y	Y
Observations	605	605	605	605
Adjusted R-squared	0.10	0.01	0.06	
Pseudo R-Squared				0.27

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

As a robustness check, we aggregate self-reported data at the community level, which is a well-established method when the outcome of interest is also at the community level (Sampson et al., 1997). Hunter et al. (2013) showed that aggregated self-reported measures of drought were strongly associated with objective measures of rainfall in Australia. Similarly, Edwards et al. (2020) finds among a Filipino sample that aggregated disaster exposure also correlated well with disaster exposure using EM-DAT data.

We generate an individual-specific average exposure to climate hazards based on other participants reports of hazards in the same community but not individual self-reports.

$$(1) \quad \text{aggregate\_hazards}_i = \frac{\sum_{j \neq i} \text{number\_hazards} - \text{number\_hazards}_i}{N_{community} - 1}$$

On average, there is positive relationship between aggregate measure and individual self-reports of climate hazards (Pearson correlation r = .14, p = .00), indicating the idiosyncratic nature of hazards as not all shocks affect the entire community in the same way. Thus, most of the variation in reported climate hazards occurs within communities not between them. Our results for risk are robust to using the aggregate measure, while the association with place identity and dependence is not. However, this analysis is also less than ideal for two reasons. First, the aggregate measure in this analysis assigns respondents who did report to have not experienced any hazards in the past five years on average with 2.6 hazards. Second, the interpretation of the model is different as we cannot net out common shocks at the community level through the inclusion of village fixed effects with the aggregate measure. While individual reports of climate hazards are prone to outliers, the aggregate measure takes most of the variation in hazards within villages away. We think the grouping of reported hazards offers the best compromise to understand individual responses (risk aversion, place attachment, aspirations) by allowing individual variation in

reported hazards (from none to 3 or more) within communities while also rigorously constraining outliers.

Table B.14 Preferences robustness check with aggregate measure of hazards

VARIABLES	Risk aversion (1)	Place identity (2)	Place dependence (3)
Aggregate hazards	0.11**	0.01	0.01
	(0.05)	(0.07)	(0.05)
Socio-economics			
Female (=1)	0.14*	-0.07	-0.02
	(0.08)	(0.09)	(0.09)
Age (years)	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)
Married (=1)	-0.11	-0.12	0.23
	(0.11)	(0.10)	(0.15)
Education	-0.00	0.01	-0.01
	(0.01)	(0.01)	(0.01)
Household size	-0.01	0.03	0.06*
	(0.04)	(0.02)	(0.03)
HH monthly income (log+1)	-0.06	0.07	-0.03
	(0.05)	(0.06)	(0.05)
HH asset value (log+1)	0.00	-0.01	-0.02
	(0.02)	(0.03)	(0.03)
Damages extremes			
Land lost erosion (=1)	-0.06	0.02	-0.15
	(0.10)	(0.08)	(0.15)
House rebuild index (PCA)	-0.05**	0.03**	0.01
	(0.02)	(0.01)	(0.03)
Vietnam (=1)	-0.74***	-0.13	-0.25*
	(0.09)	(0.16)	(0.14)
Constant	0.32	-0.59	-0.24
	(0.36)	(0.60)	(0.52)
Cluster	16	16	16
Observations	605	605	605
Adjusted R-squared	0.10	0.00	0.06

Notes: Standard errors are clustered at the community level and bootstrapped with 500 replications to account for few clusters: *** p<0.01, ** p<0.05, * p<0.1

Table B.15 Excluding all migrants in our sample

VARIABLES	Risk (z-score) (1)	Identity (z-score) (2)	Dependance (z-score) (3)	Aspiration to move abroad (=1) (4)
Hazards: 1 or 2	0.19	0.10	0.15	0.09*
	(0.13)	(0.11)	(0.12)	(0.05)
Hazards: 3 or more	0.25**	0.32***	0.05	0.22***
	(0.12)	(0.11)	(0.12)	(0.05)
Socio-economics				
Female (=1)	0.11	0.02	-0.02	0.03
	(0.10)	(0.09)	(0.10)	(0.04)
Age (years)	0.01***	0.00	0.01**	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Married (=1)	-0.23**	-0.02	0.28**	0.01
	(0.12)	(0.11)	(0.13)	(0.05)
Education	-0.00	0.00	-0.03**	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Household size	-0.05	0.03	-0.08	0.11***
	(0.05)	(0.05)	(0.05)	(0.03)
HH monthly income (log+1)	0.03	-0.00	0.02	0.02
	(0.03)	(0.04)	(0.03)	(0.01)
HH asset value (log+1)	-0.03	-0.01	0.05*	-0.02

	(0.03)	(0.02)	(0.03)	(0.01)
Damages extremes				
Land lost erosion (=1)	-0.08	-0.06	-0.30**	-0.07
	(0.13)	(0.10)	(0.13)	(0.05)
House rebuild index (PCA)	-0.04	-0.04	-0.01	-0.00
	(0.04)	(0.03)	(0.03)	(0.01)
Constant	0.24	-0.20	-0.36	
	(0.42)	(0.43)	(0.44)	
Observations	433	433	433	433
Adjusted R-squared	0.12	0.01	0.10	
Pseudo R-Squared				0.32

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

B.3.3 Heterogeneous treatment effects

Table B.16 shows the regression models underlying Fig. 3.4 reported in the main manuscript. Table B.17 shows a related model using interaction terms using the pooled sample as a robustness check.

Table B.16 Determinants of migration aspirations across groups

	Aspiration to move abroad (=1)			Aspiration to move to high-income destination (=1)		
	None	1 or 2	3+	None	1 or 2	3+
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Risk aversion (z-score)	0.01	-0.03	-0.07**	0.02	0.01	-0.03
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Identity (z-score)	0.02	-0.09**	0.04	0.05	-0.02	0.11***
	(0.04)	(0.04)	(0.03)	(0.05)	(0.05)	(0.03)
Dependence (z-score)	-0.03	0.06	-0.01	-0.05	-0.04	-0.06*
	(0.04)	(0.05)	(0.03)	(0.05)	(0.05)	(0.04)
Socio-economics						
Female (=1)	0.11*	0.03	0.02	-0.00	-0.01	0.10
	(0.06)	(0.06)	(0.06)	(0.08)	(0.07)	(0.06)
Age	-0.01**	-0.00	-0.00	-0.01**	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married (=1)	0.02	-0.05	0.09	0.16	0.03	0.12
	(0.09)	(0.07)	(0.07)	(0.11)	(0.08)	(0.08)
Education	-0.01	0.01	0.01	-0.00	0.02*	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HH monthly income (log+1)	0.08**	0.06*	0.07	0.07	0.03	0.07
	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)	(0.05)
HH asset value (log+1)	0.00	0.02	0.04*	0.01	0.06**	0.05*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Household size	-0.01	-0.03	-0.01	0.02	-0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Damages						
Land lost erosion (=1)	0.06	-0.09	0.00	0.02	-0.19**	-0.07
	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.07)
House rebuild index (PCA)	-0.05**	-0.01	0.03*	0.01	0.01	0.02
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Vietnam (=1)	-0.67***	-0.58***	-0.39***	-0.13	0.00	0.08
	(0.07)	(0.06)	(0.07)	(0.11)	(0.09)	(0.09)
Observations	164	203	238	164	202	238
Pseudo R-squared	0.38	0.30	0.20	0.10	0.10	0.16

Notes: Estimates are average marginal effects calculated after probit regressions. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B.17 Heterogeneous effects for migration aspirations depending on preferences

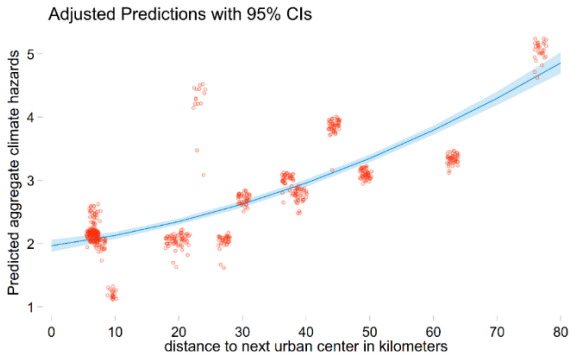
	Aspiration (=1)			High-income destination (=1)		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)

1 or 2 extremes	0.10**	0.10**	0.10**	0.02	0.02	0.03
	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
3 or more extremes	0.18***	0.17***	0.18***	0.09*	0.08	0.09*
	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Risk aversion	0.01	-0.03	-0.03	0.04	-0.00	-0.00
	(0.03)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)
1 or 2 extremes * Risk aversion	-0.03			-0.03		
	(0.04)			(0.05)		
3 or more extremes * Risk aversion	-0.10**			-0.09*		
	(0.04)			(0.05)		
Place identity	0.01	0.02	0.01	0.06***	0.07	0.07***
	(0.02)	(0.04)	(0.02)	(0.02)	(0.04)	(0.02)
1 or 2 extremes * Place identity		-0.06			-0.08	
		(0.05)			(0.05)	
3 or more extremes * Place identity		0.03			0.04	
		(0.04)			(0.05)	
Place dependence	-0.01	-0.00	-0.01	-0.06**	-0.05**	-0.05
	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.04)
1 or 2 extremes * Place dependence			-0.02			-0.06
			(0.05)			(0.05)
3 or more extremes * Place dependence			0.01			0.01
			(0.04)			(0.05)
Constant	0.39**	0.38**	0.39**	-0.31*	-0.32*	-0.31*
	(0.16)	(0.15)	(0.15)	(0.18)	(0.18)	(0.18)
Joint F-test interaction	0.00	0.00	0.00	0.19	0.02	0.25
Observations	605	605	605	604	604	604
R-squared	0.30	0.30	0.30	0.12	0.13	0.12
Adjusted R-squared	0.28	0.28	0.27	0.10	0.10	0.09

Notes: Controlling for socio-economics, damages and country-fixed effects. Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

We find evidence that communities closer to urban centers tend to be less affected by climate hazards than more rural communities. The predicted relationship between aggregate community reports of climate hazards for a range of distances to the next urban center with more than 100,000 residents overlayed with a scatterplot of the underlying data (see Fig. B.3). The further a community is away from an urban center the more hazards are reported on aggregate by (Pearson correlation r = .81, p = .00). Using a median split shows that communities that are closer (below median distance to urban center of 27km) report on average only 2.1 hazards in the past five years while more rural communities report 3.2 (p = .00).

Fig. B.3 Predicted relationship between climate hazards and distance to urban center

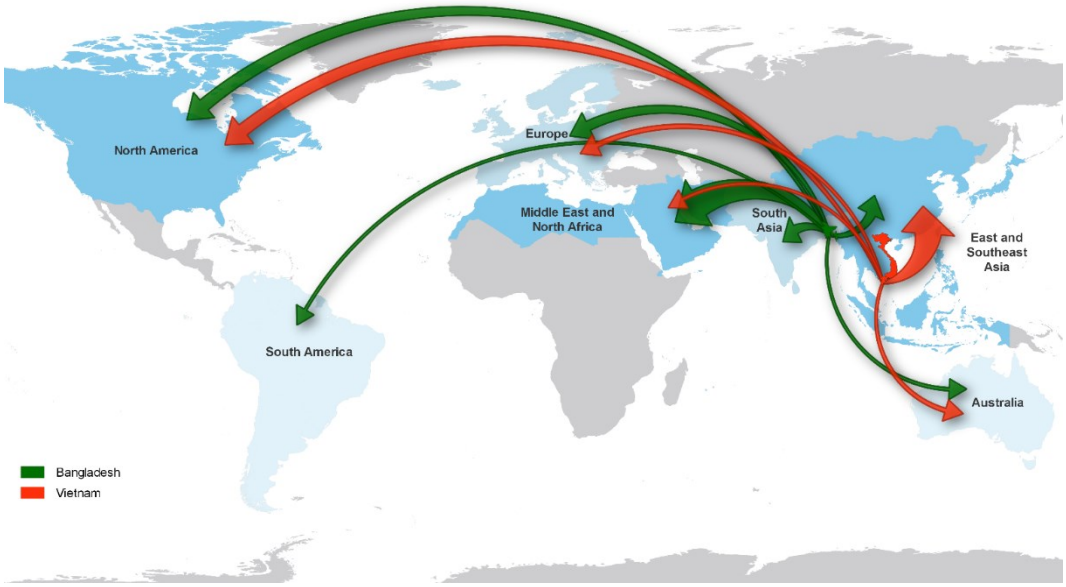


Notes: Marginsplot of predicted climate hazards for a range of distances to urban centers. The reported results from the regression model including the squared distance to urban centers yields slightly better model fit (adjusted R-squared = 0.68).

B.4 International migration aspirations, likelihood and reasons

When respondents were asked where they would move abroad and why we find that they can aspire to a life beyond their national borders: 88% of respondents in Bangladesh and 45% in Vietnam aspired to move abroad. All but one respondent from Vietnam with an aspiration would like to move to a high-income country such as the USA, Australia, any European country, or also South Korea and Singapore in East Asia, while only 44% (n = 94) of respondents from Bangladesh do. The main self-stated reasons for these aspirations are not related to climate and environmental impacts, but rather because of the economic possibilities and general living standard in these countries (see Table B.18). About 10% that aspire to move to a high-income country (n = 27) have relatives living there that they want to reunite with. Nearly half of respondents from Bangladesh (n = 98) aspire to move to the MENA region for religious and economic reasons and the last 10% (n = 25) aspire to move to India because they have relatives there and its proximity to Bangladesh. Respondents that do not aspire to a life beyond their national borders stated that they either had no desire to do so or never actually thought about moving somewhere else.

FIG. B.4 INTERNATIONAL MIGRATION ASPIRATIONS

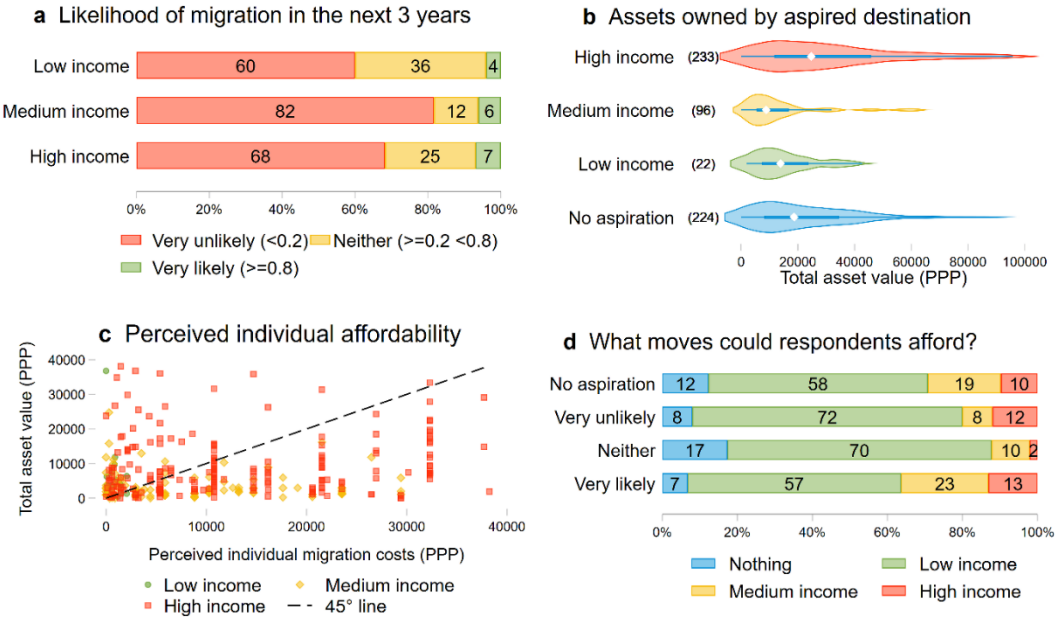


Notes: The thickness of each flow between origin and destination is adjusted to the share of all respondents who aspire to move to that region. Regions are colored based on the total share of respondents naming that region. Most respondents aspire to move to high-income countries (East Asia n = 128, North America n = 84, Europe n = 38, and Australia n = 11), followed by middle-income in the Middle East and North Africa (n = 98) and least preferred are close by South Asian countries (n = 25), mainly India. Created in QGIS based on our data.

To get an idea about the perceived feasibility to act on these aspirations, we asked all respondents who aspire to move abroad (n = 385) how likely they think it is that they move abroad within the next three years (see Fig. B.5A). Overall, 71% of respondents with an aspiration assessed it as "very unlikely" (n = 274), while only 6% are optimistic (n

= 25) to move abroad. The other 22% (n = 86) perceive their chances as neither "very likely" nor "very unlikely". We find no large differences in the likelihood of migration between the different destination regions. Fig. B.5B shows the wealth distribution over migration destinations. While it could be the case that people might simply not aspire to move abroad because they lack the funds, we find no evidence that respondents with no aspiration (*median* $20,619 PPP adjusted) are significantly less wealthy than respondents who aspire to move abroad (*median* $20,882 PPP adjusted) (Mann-Whitney *U*-Test, $z = -.83$, $p = .41$).

Fig. B.5 Migration likelihood and financial feasibility



Notes: Panel A shows how likely respondents who aspire to move abroad think it is that they move to their aspired destination in the next three years, considering all financial and legal obstacles. Panel B shows respondents' wealth distribution by aspired destination regions clustered into low-, medium-, and high-cost destinations. The self-assessed value of all household assets is used to approximate wealth and includes the following assets: livestock, immovable assets (land, house), and other movable assets (car, boat, agricultural equipment). We lose 11 observations due to missing's in the reported assets. Panel C plots self-stated migration costs for the named destination (x-axis) against respondents' asset value divided by household size (y-axis). Named low-cost migration destinations include India and Pakistan, medium cost destinations are MENA countries like Saudi Arabia or Oman, and high-cost destinations include Australia and countries in Europe, North America, and East Asia (Japan, South Korea). Panel D shows respondents' affordability, based on the aggregate migration costs**,** to move to low-, medium-, and high-cost destinations by likelihood to act on their aspiration.

Being very certain to migrate within the next three years implies having enough wealth to do so. To understand the ability of respondents to act upon their aspirations, we plot respondents' self-assessed costs for their migration aspirations against their wealth (Fig. B.5C). Respondents were asked to consider all possible costs of moving, including having enough money to support themselves in the first month at the destination. For all respondents below the 45-degree line, the perceived migration costs exceed their wealth. Overall, 35% of the respondents with an aspiration perceive to be able to afford to move to the named country. Movements to high income destinations are perceived as more costly

(*median* $10,771 PPP) than to medium- (*median* $5,882 PPP) and low-income destinations (*median* $588 PPP). The standard deviations around these mean values reveal substantial difficulties in estimating migration costs for respondents. Given that getting a visa or working permit involves substantial payments to intermediaries and travel costs, estimates for high-cost destinations below $5,000 are unrealistic. Especially in Bangladesh, respondents seem to underestimate these costs, as 56% of respondents who aspire to move to North America estimated the costs to be less than $5,000 PPP. While individual estimates of migration costs might be imprecise, aggregating them reveals a realistic picture of migration costs to different destinations. The average perceived migration costs are, for example, strongly correlated with the migration costs to the same destinations based on official labor migration data from Bangladesh (Pearson-correlation r = .75, p = .00). In Fig. B.5D, we show where respondents could afford to go based on the aggregate migration costs. Overall, 11% (n = 65) of our respondents could not even afford to move to a low-income destination, 60% (n = 370) could afford to move to a low-cost and 19% (n = 117) to a medium-income destination. Only 60 out of 613 (10%) respondents could afford a move to a high-cost destination. Yet, only three of them assessed their likelihood to move to their aspired high-income destination as "very likely" (South Africa, Australia, Thailand).

Table B.18 Reasons and steps for international migration by destination region

	North America	Europe	South Asia	East Asia	Australia	MENA	Total
Estimated costs (PPP)	22266	21272	768	17252	17208	9196	15372
Wealth adjusted for HH size	15434	8209	16546	10492	11289	4618	10240
Affordability (costs/wealth)	0.33	0.26	0.92	0.35	0.55	0.31	0.37
Open question: Any reasons for choosing that country?							
Religious	0.00	0.00	0.08	0.01	0.09	0.51	0.14
Economic	0.39	0.42	0.04	0.27	0.27	0.27	0.30
Social network	0.08	0.13	0.28	0.11	0.09	0.06	0.10
Proximity	0.00	0.00	0.28	0.02	0.00	0.00	0.02
Standard of life	0.40	0.32	0.04	0.31	0.36	0.06	0.25
No reason	0.10	0.06	0.00	0.26	0.20	0.00	0.12
Open question: What concrete steps would you have to take to move to this country legally?							
Passport	0.36	0.45	0.56	0.20	0.27	0.68	0.41
Visa	0.35	0.58	0.40	0.29	0.36	0.53	0.40
Language	0.26	0.11	0.00	0.30	0.27	0.06	0.19
Money	0.10	0.13	0.04	0.11	0.27	0.17	0.13
ID Card	0.20	0.08	0.04	0.28	0.09	0.04	0.16
Ticket	0.00	0.03	0.00	0.00	0.09	0.07	0.02
No step mentioned	0.19	0.22	0.36	0.32	0.10	0.12	0.23
N	84	38	25	128	11	98	384

Notes: The table shows only responses for people that named a country in response to the question: "If you could migrate abroad, where would you go and why?" Respondents that did not name a place abroad when asked where they would migrate abroad most often mentioned "I want to live in Vietnam/Bangladesh" or "never thought about that". All categories reported for the open questions were created based on a content analysis of the responses (multiple categories could be named by respondents).

C. Chapter 4: Supplementary material

The supplementary materials for chapter 4 are organized as follows: In supplementary section C.1, we provide information on pre-registration and pre-tests conducted. In section C.2 we offer a detailed literature review. Section C.3 provides information on the study site and data collection. Section 4 outlines the exclusion criteria. Section 5 investigates attrition. Section C.6 offers a detailed account on study methods. Section C.7 offers balancing and manipulation checks. C.8 presents sample details and a comparison to the general German population. C.9 presents additional results and robustness checks of the main results. C.10 investigates demand effects. C.11 investigates the external validity, and in C.12 experimental materials are presented.

C.1 Survey registration, and pre-test

C.1.1 Pre-registration

Data collection and analysis were preregistered on AsPredicted (Ref. 66735) and can be accessed at https://aspredicted.org/WAA_TNE. The aim of our study is to investigate whether information and reminders can encourage participants to get vaccinated as measured by their self-reported intention to vaccinate and their vaccination action.

We outlined our plan to conduct three surveys between Mai and December 2021. At the time of writing, the third and final survey has not yet been conducted. However, as the last survey was intended only as a follow-up in the event of low vaccination rates or supply shortages in the summer – neither of which has occurred – we are confident that the results of the first two surveys are already informative and important.

We intended to capture participants' other-regarding preferences by using the 6-item social value orientation task (SVO) from Murphy et al. (2021). However, due to a programming error, we were unable to reliably capture participants' responses, resulting in several missing responses. Therefore, we decided to exclude the social value orientation task from our analysis. In section C.9 we show that this does not affect our main results.

C.1.2 Pre-test

We pre-tested our survey experiment with 575 students from the University of Marburg in May 2021. Thanks to the often very detailed comments we received, we were able to improve and clarify some questions. This also allowed us to arrange the information in the debunking and benefit treatment so that the information rated "most interesting" in the pretest was displayed first.

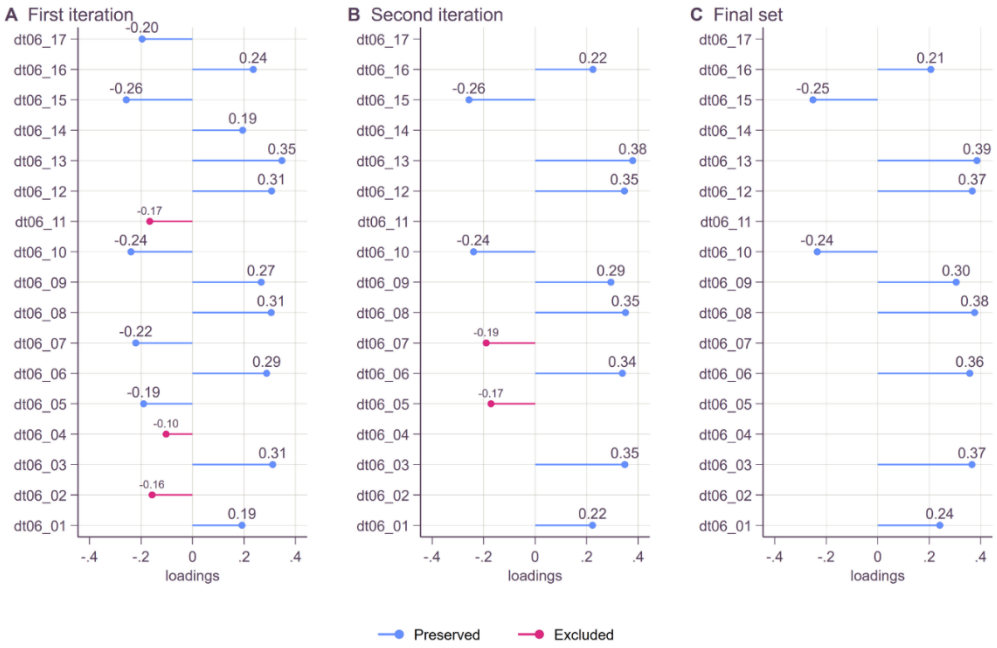
We also used the pre-test to reduce Altemeyer's (2002) dogmatism scale from 18 items to 10 items. There were two reasons for this: We wanted to keep the questionnaire as short as possible for the participants, and some of the items seemed repetitive, especially after translation into German. For example, item number 18, see Table C.1, was excluded because it seemed to cause confusion among participants and we, therefore, considered the responses unreliable. We apply principal component analysis to exclude items with low loadings. In the first iteration, we excluded all items with loadings below .19. This threshold was set to avoid prematurely excluding items that were close to .20. In the second iteration, in which the loadings for the remaining items are recalculated, we exclude all items with loadings below .20. Further reduction of items would have reduced the explanatory power of the principal component analysis. For reasons of comparability and reproducibility, we report average values in our analysis to control for participants' dogmatic attitudes, not principal components.

Table C.1 Complete dogmatism scale

Variable	*To what extent do you agree with the following statements? [Do not agree at all 1 |---| 7 Fully agree]*	***Preserved***
dt06_01	1. Anyone who is honestly and truly seeking the truth will end up believing what I believe.	X
dt06_02	2. There are so many things we have not discovered yet, nobody should be absolutely certain his beliefs are right. R	
dt06_03	3. The things I believe in are so completely true, I could never doubt them.	X
dt06_04	4. I have never discovered a system of beliefs that explains everything to my satisfaction. R	
dt06_05	5. It is best to be open to all possibilities and ready to reevaluate all your beliefs. R	
dt06_06	6. My opinions are right and will stand the test of time.	X
dt06_07	7. Flexibility is a real virtue in thinking, since you may well be wrong. R	
dt06_08	8. My opinions and beliefs fit together perfectly to make a crystal-clear "picture" of things.	X
dt06_09	9. There are no discoveries or facts that could possibly make me change my mind about the things that matter most in life.	X
dt06_10	10. I am a long way from reaching final conclusions about the central issues in life. R	x
dt06_11	11. The person who is absolutely certain she has the truth will probably never find it. R	
dt06_12	12. I am absolutely certain that my ideas about the fundamental issues in life are correct.	X
dt06_13	13. I am so sure I am right about the important things in life, there is no evidence that could convince me otherwise.	X
dt06_14	14. If you are "open-minded" about the most important things in life, you will probably reach the wrong conclusions.	
Dt06_15	15. Twenty years from now, some of my opinions about the important things in life will probably have changed. R	x
dt06_16	16. "Flexibility in thinking" is another name for being "wishsy-washy".	X
dt06_17	17. No one knows all the essential truths about the central issues in life. R	
dt06_18	18. Someday I will probably realize my present ideas about the BIG issues are wrong. R	

Note: Table C.1 shows the complete dogmatism scale from Altemeyer (2002) and what items were included in our final measurement.

Fig. C.1 Compression of dogmatism scale



Note: Loadings of the individual items from Altemeyer's (2002) complete dogmatism scale, see Table C.1, are shown. Items that were excluded are highlighted in orange. Using principal component analysis, we calculate the loadings for each item. Panel A shows the first iteration, in which all items with loadings below .19 were excluded. Panel B shows the second iteration, where all items below .20 were excluded. Panel C shows the loadings of the remaining items.

C.2 Literature review

In this section, we briefly review the literature on vaccine hesitancy in general and hesitancy towards COVID-19 vaccines in particular. As we considered this review too extensive for the main manuscript, we decided to include only a brief summary in the introduction and present the rest here.

C.2.1 Vaccination hesitancy in general

Vaccination hesitancy – the reluctance or refusal to vaccinate despite the availability of vaccines – has existed ever since the first vaccines were developed in the early 1800s and has never completely gone away since then (Dubé et al., 2015b; Wolfe and Sharp, 2002). While the methods of information-sharing and motives of the anti-vaccination movements have changed over the last 200 years, a great overlap in arguments remains. Vaccines continue to be portrayed as ineffective, disease-causing, containing harmful substances, and authorities are accused to conceal the harm caused by vaccines. Moreover, it is argued that alternative health products such as homeopathy or vitamins are superior to vaccines and that natural immunity is better than vaccine-induced immunity. Thus, vaccination mandates are presented as a violation of civil rights and only serve the companies that manufacture vaccines for profit (Dubé et al., 2015b). The growth of the anti-vaccine movement poses an ever-increasing problem for global health, as more and more people view vaccines as unsafe and unnecessary (de Figueiredo et al., 2020; Dubé et al., 2021). At

the beginning of the 2000s vaccination rates plummeted across many high-income countries (Dubé et al., 2013; McIntosh et al., 2016; Williams, 2014; Wolfe and Sharp, 2002) as well as low- and middle-income countries (Rainey et al., 2011). This led to a "comeback" of vaccine-preventable diseases that were once brought under control – such as measles, poliomyelitis, and pertussis (Falagas and Zarkadoulia, 2008; Paules et al., 2019).

Decades of research on vaccination hesitancy have shown that hesitancy is complex, multifaceted, and context-specific (for an overview see (Dubé et al., 2015a). A large share of variation in hesitancy can be explained by differences in (i) sociodemographic characteristics, (ii) cultural, institutional, and political factors, as well as (iii) psychological factors (Dubé et al., 2013; Falagas and Zarkadoulia, 2008; Larson et al., 2014; Rainey et al., 2011; Schmid et al., 2017; Williams, 2014). However, there is not one universal factor that consistently explains hesitancy as determinants vary not only across countries and vaccine types but also over time. While sociodemographic characteristics – such as age, gender, socio-economic status, ethnicity – are the most reported determinants of vaccination hesitancy literature reviews found large inconsistencies in these variables. Some studies associate higher socioeconomic status and age with higher procrastination while others find the opposite effect (Larson et al., 2014; Schmid et al., 2017). Furthermore, norms such as encouragement from others or social pressure, as well as knowledge on the vaccine and vaccine-preventable diseases increased uptake in some countries (Larson et al., 2014; Schmid et al., 2017). But health knowledge influenced by myths and rumors (Nigeria) as well as anthroposophist beliefs (Netherlands) worked as a barrier (Larson et al., 2014).

One approach to mapping the different determinants of vaccination hesitancy is the 5C model, which elicits people's Confidence in the safety and efficacy of the vaccine, Complacency about the risk of infection, Constraints that prevent one from vaccinating, Calculation of one's own costs and benefits, and the perceived Collective responsibility to vaccinate (Betsch et al., 2018). This approach is based on extensive literature review and testing by the Strategic Advisory Group of Experts on Immunization (SAGE) who worked out three key determinants of vaccination hesitancy (Strategic Advisory Group of Experts on Immunization, 2014): The trust in the effectiveness and safety of the vaccine as well as health workers and policymakers (Confidence), the belief of the need of the vaccine (Complacency), and the ability to obtain the vaccination (Complacency). This model was later extended to include people's perceived costs and benefits of vaccination (Calculation) (Betsch et al., 2015) and by the willingness to protect others (Collective responsibility) to the 5C model (Betsch et al., 2018). While there is some discussion in the literature to include further categories (Wismans et al., 2021), we decided to adopt the more established 5C model in our study.

C.2.2 Vaccination hesitancy towards COVID-19 vaccines

The development of the COVID-19 vaccines provided a unique opportunity to study vaccination hesitancy on an unprecedented scale. Vaccine development was extensively covered by the media around the world and vaccines were released simultaneously in many countries, although predominantly in high-income countries first. Furthermore, COVID-19 vaccines were relevant to all segments of society, in contrast to many previous vaccination campaigns that primarily focused on parents vaccinating their children (Dubé et al., 2013; Larson et al., 2014). Since most studies on COVID-19 vaccination hesitancy that have been published at the time of writing investigate hesitancy based on vaccination intentions, not actions, conclusion on what drives this hesitancy might change over time as more studies are published that also consider vaccination actions.

Nevertheless, the research on COVID-19 vaccines hesitancy already sheds some light on the connection of (i) sociodemographic characteristics, (ii) cultural, institutional, and political factors, as well as (iii) psychological factors that might explain hesitancy. Sociodemographic characteristics such as age, gender, affluence, and education seem to be important for vaccination hesitancy across many different contexts (Cascini et al., 2021; Troiano and Nardi, 2021). While many studies in western countries find that female, younger, less educated, and less affluent individuals are more likely to be hesitant in Australia (Edwards et al., 2021), France (Schwarzinger et al., 2021), the US (Daly and Robinson, 2021; Petersen et al., 2021; Ruiz and Bell, 2021), as well as Ireland and the UK (Murphy et al., 2021), there are some notable exceptions. In Denmark, for example, females seem to be more supportive of COVID-19 vaccination than males (Petersen et al., 2021). Lazarus et al. (2021) surveying 13,426 people in 19 countries conclude that globally speaking being male, older, less educated, less affluent is associated with higher hesitancy.

Cultural, political, and institutional differences such as lower trust in authorities (Cascini et al., 2021; Edwards et al., 2021; Kerr et al., 2021; Lindholt et al., 2021; Murphy et al., 2021) and support of populist views (Edwards et al., 2021; Gerretsen et al., 2021) were also found to correlate with higher COVID-19 hesitancy. It seems that COVID-19 policies, as well as the vaccination debate, were politicized in many countries. It is therefore not surprising that studies find a correlation between vaccination hesitancy and support for a particular party, such as the republicans in the US (Ruiz and Bell, 2021), or the far-right AfD in Germany (Desson et al., 2021). There are also likely to be institutional factors – as indicated by the varying levels of trust in authorities – and cultural factors – such as the prevalence of anthroposophical movements (Fournet et al., 2018). These factors are certainly important to explain how hesitancy emerges, yet it is difficult, sometimes even impossible, to change them on short notice. Therefore, we focus more on

psychological determinants here, as interventions that target people's attitudes, perceptions, and opinions are likely more fruitful in swiftly reducing hesitancy.

Ruiz and Bell (2021), for example, find that general vaccination knowledge and personal COVID-19 threat appraisal are associated with higher vaccination acceptance in the US; Murphy et al. (2021) find that – among other psychological determinants – lower levels of trust in scientists, health care professionals, and the state, as well as lower levels of altruism, are associated with higher hesitancy in both Ireland and the UK; and Edwards et al. (2021) find that people with greater confidence in their government, hospitals, and state systems were less likely to be against vaccination in Australia. Furthermore, Gerretsen et al (2021) show that two of the three factors of the 3Cs – Confidence (38%) and Complacency (21%) – model have the highest explanatory power before socio-demographics (13%) and other psychological factors (11%) in the US and Canada. While Wismans et al. (2021) applying the 5C model find that Confidence and Collective Responsibility are most strongly related to COVID-19 vaccination hesitancy in a survey including 1,137 university students from the Netherlands, Belgium, and Portugal. Applying mediation analyses, the authors argue that "the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly relate to vaccination intention through Confidence." Furthermore, "the perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly relate to vaccination intention through Collective Responsibility."

C.2.3 Vaccination hesitancy in Germany

Studies looking at vaccine hesitancy in Germany prior to COVID-19 find that vaccination hesitancy correlates with lower risk appraisal of the disease, negative attitudes towards immunization, or having a migration background (Boes et al., 2017; Poethko-Müller et al., 2009; Rehmet et al., 2002). Nevertheless, hesitancy seems to decrease if physicians recommend vaccination (Boes et al., 2017) or simply when having a family physician (Rehmet et al., 2002). Interestingly, vaccination hesitancy prior to COVID-19 was also found to be lower for persons residing in parts of former East Germany (Boes et al., 2017; Poethko-Müller et al., 2009; Rehmet et al., 2002). For COVID-19 vaccines this correlation is reversed, with higher hesitancy in the east compared to the west (Desson et al., 2021). Beyond regional differences COVID-19 vaccination hesitancy seems to correlate with being female, older, better educated, and more affluent in Germany (Bendau et al., 2021; Graeber et al., 2021; Umakanthan and Lawrence, 2022). However, COVID-19-related anxiety, fears of infection, overall risk appraisal of the pandemic, and support for COVID-19 policies appear to be strong indicators for getting vaccinated (Bendau et al., 2021; Graeber et al., 2021; Umakanthan and Lawrence, 2022).

Overall, hesitancy in Germany is likely related to the prevalent tradition of Anthroposophy (Fournet et al., 2018), widespread acceptance of homeopathy funded by the health care system (Altenbuchner et al., 2021), and support for right-wing politics (Desson et al., 2021). In these aspects, Germany seems to be comparable to other German-speaking countries – Austria and Switzerland – with whom it shares substantial cultural, historical, and economic ties. All three countries have a similar system of federalism, operate a system of mandatory universal health care, and applied similar strategies to contain the initial COVID-19 outbreak – school closures, the obligatory wearing of masks, social distancing, increased testing, and contact tracing. Shared cultural elements, such as low intergenerational contact and cohabitation, may also have contributed to keeping initial fatalities low (Desson et al., 2020). A less positive development these three countries share is the plateauing of vaccination rates at a suboptimal level (between 50 and 65%) by the end of September 2021 the reason for which is seen in a high vaccination hesitancy (Desson et al., 2021). Although the reasons for this hesitation are admittedly complex and interrelated, some similarities between the German-speaking countries can be identified. In all three countries vaccination rates vary regionally – Germany: Bremen 78% vs Saxony 56%, Austria: Burgenland 67% vs. Oberösterreich 55%, Switzerland: Ticino 57% vs 42% Appenzell Innerrhoden). Furthermore, support for right-wing parties (Germany: Alternative for Germany (AfD), Austria: Freedom Party of Austria (FPO), Switzerland: Swiss People's Party (SVP)) has been found to be associated with higher vaccination hesitancy (Desson et al., 2021).

C.3 Data collection and study site background

While Germany never faced a hard lockdown in which freedom of movement was completely restricted, several other policies were implemented to reduce the spread of COVID-19. In Mai 2021, contact restrictions in private and public spaces were still in place. Moreover, anyone traveling to a high incidence area had to go into quarantine for 14 days or until they received a negative test result. When COVID-19 vaccines became towards the end of 2020, the German government put a vaccination prioritization system in place: Highest priority: Being above 80, living in care facilities being highly vulnerable, or working in care facilities being highly exposed. High priority: Being above 70, certain illnesses making people vulnerable, up to two contact persons of each person needing care, and working in areas of mid exposition. Increased priority: Being above 60, having certain illnesses, working with low exposition, and working in areas of high importance (alimentation, transport, pharmacy, etc.). Vaccination prioritization was officially lifted in Germany on June 5th. Yet, since appointments were organized several weeks in advance, people were already invited to sign up for appointments mid May 2021. As we were

interested in participants intention to get vaccinated and their subsequent actions, we chose this period were vaccinations were made widely available as the first survey phase. Hence, the survey experiment was implemented between Mai 25th and June 2nd. In the following months, with much of the demand satisfied waiting lists and sometimes even appointments became obsolete in vaccination centers. As a substantial part of the population still was unvaccinated despite availability of vaccines, policies were discussed to increase the vaccination uptake. At the time of the study, monetary incentives have been discussed but not employed. Mobile vaccination teams, invitations for vaccination, and vaccination in public places (e.g., in front of sport stadiums at game-days) have been put to practice between the survey experiment and the follow-up survey. Exclusion from public events for unprotected (unvaccinated and not recovered) and stop of free official testing were not employed throughout the study period. However, after our study was completed, free official testing was stopped for about one month between October 11 and November 13. Furthermore, access to stores (except food retailers, pharmacies, post office, etc.) and restaurants was restricted to those vaccinated or recovered in several federated states in Germany from the beginning of December onwards, i.e., both stop free testing and exclusion of non-vaccinated or non-cured were already a topic of debate during the study period. At the time of our follow up survey between September 6th and 18th 2021 all participants have had ample opportunity to be vaccinated. Furthermore, as all policies tested in our survey have been debated in the general public at that time it is likely that they have thought about the measures themselves beforehand. For example, to counteract the spread of vaccination myths, the German government (https://www.zusammengegencorona.de/) and RKI (https://www.rki.de/SharedDocs/FAQ/COVID-Impfen/gesamt.html) set up pages providing corrective information, such as in Switzerland (https://bag-coronavirus.ch/impfung/nebenwirkungen-fragen/) or the US (https://www.cdc.gov/vaccines/COVID-19/health-departments/addressing-vaccine-misinformation.html).

C.4 Exclusion criteria

C.4.1 Survey experiment

As we outlined during pre-registration, we invited only unvaccinated participants. Nevertheless, 1.2% (91 out of 1,623) of participants who completed the survey reported being either partially or fully vaccinated at the first survey in May 2021. These individuals were therefore excluded from the study. As outlined in the pre-registration, participants who completed the survey in less than 5 minutes (4.5%, 69 out of 1,532) or showed signs of inattention (1%, 16 out of 1,463) were excluded.

Additionally, at the end of the survey, we asked participants if they answered all questions as instructed, if they were unable to answer certain questions due to technical issues, or if they gave random answers. Participants were informed that their answer would not affect their payment, as everyone who successfully completed the survey would receive payment. We did not include this exclusion criterion in the pre-registration because we were unsure how well it would work. Of the 1,447 participants, 4 (.3%) reported having technical issues, 77 (5.3%) reported occasionally have given random answers, and 7 (.5%) participants reported frequently giving random responses. To improve the overall quality of the data, we believe it is better to exclude data where participants report having given random responses. Therefore, we decided to exclude these observations from the main analysis.

Finally, having a panel dataset allows us to check if participants provided accurate responses by controlling for whether their reported age changed by more than one year (2.2%, 30 out of 1,359) or whether participants changed gender between the two surveys in May and September 2021 (.4%, 5 out of 1,329). Excluding these observations yields a final sample of N = 1,324 observations for the survey experiment. While participants excluded differ from those not excluded (see Table C.2) the overall results do not change by excluding participants in the analysis of the survey experiment (Table C.13) and the panel (Table C.16).

Table C.2 Balance table: Main sample and excluded

	(1) Main sample		(2) Excluded		Difference t-test
VARIABLES	N	Mean/SE	N	Mean/SE	(1)-(2)
Control variables					
Female (=1)	1324	0.511 [0.014]	208	0.385 [0.034]	0.127***
Age: <30	1324	0.202 [0.011]	208	0.308 [0.032]	-0.105***
Age: 30-39	1324	0.128 [0.009]	208	0.231 [0.029]	-0.103***
Age: 40-49	1324	0.218 [0.011]	208	0.149 [0.025]	0.069**
Age: 50-64	1324	0.371 [0.013]	208	0.240 [0.030]	0.130***
Age: 65+	1324	0.081 [0.007]	208	0.072 [0.018]	0.009
Secondary school: "Hauptschulabschluss"	1324	0.113 [0.009]	207	0.164 [0.026]	-0.051**
Secondary school: "Realschulabschluss"	1324	0.347 [0.013]	207	0.329 [0.033]	0.018
High school: "Fach & allg. Hochschulberechtigung"	1324	0.284 [0.012]	207	0.266 [0.031]	0.018
University degree	1324	0.256 [0.012]	207	0.242 [0.030]	0.014
Adjusted Household-Income	1324	4.013 [0.049]	208	3.552 [0.124]	0.460***
Married	1324	0.412 [0.014]	208	0.370 [0.034]	0.041

Explanatory variables					
Denied other vaccines	1324	0.141	208	0.163	-0.022
		[0.010]		[0.026]	
Index: COVID-19 risk perception	1324	39.409	208	41.704	-2.295
		[0.617]		[1.335]	
Index: Emotional response to COVID-19	1324	3.612	208	3.678	-0.066
		[0.041]		[0.094]	
Net anticipated regret	1324	0.951	208	0.188	0.763***
(no vaccination – vaccination)		[0.110]		[0.220]	
Index: Dogmatism	1324	3.954	208	4.165	-0.210***
		[0.026]		[0.054]	
Outcome variables					
Vaccination intention: mRNA	1324	5.166	208	4.567	0.599***
		[0.064]		[0.147]	
Vaccination intention: Vector	1324	3.319	208	3.462	-0.143
		[0.064]		[0.139]	
5C: Confidence mRNA	1324	4.709	208	4.457	0.252*
		[0.054]		[0.121]	
5C: Confidence Vector	1324	3.909	208	3.944	-0.035
		[0.051]		[0.110]	
5C: Constraints	1324	2.174	208	3.207	-1.033***
		[0.037]		[0.115]	
5C: Complacency	1324	3.187	208	3.882	-0.695***
		[0.049]		[0.114]	
5C: Calculation	1324	5.080	208	4.918	0.162
		[0.044]		[0.095]	
5C: Collective responsibility	1324	5.052	208	4.556	0.496***
		[0.050]		[0.102]	
Vaccination inaction (=1)	1324	0.525	208	0.510	0.015
		[0.014]		[0.035]	

Note: The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Column (1) shows the means of the reduced sample used for the analysis in the paper. Column (2) shows the means for those participants excluded from the analysis due to the criteria defined. One participant excluded (column 2) specified his education in a way that could not be attributed to the above-mentioned categories.

C.4.2 Balanced panel

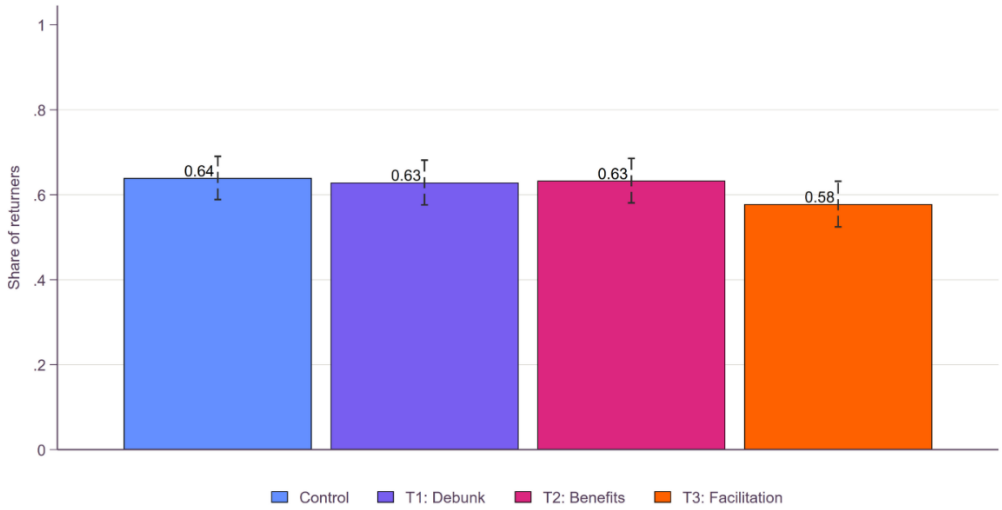
In September 2021, 987 participants completed the second survey. Applying the same criteria as in the first survey, 30 out of 987 (3.0%) participants were excluded because they completed the survey in less than 5 minutes, but no observations were removed due to lack of attention. Of the remaining 957 participants, 2 (.2%) reported experiencing technical issues, 58 reported occasionally giving random responses, and 6 reported frequently giving random responses. Removing these observations yields a sample size of N = 891 of which we further exclude 37 (4.2%) participants who were excluded from the first survey due to the exclusion criteria. Finally, we also remove the 28 participants who changed their age by more than one year and the 5 participants who changed gender, resulting in a final sample size of N = 821 for the balanced panel.

C.5 Attrition

As expected not all participants who took part in the survey experiment in May 2021 returned for the follow-up survey in September 2021. Although 987 of 1,324 participants

completed the follow-up survey, only 821 observations are considered for analysis due to the pre-registered exclusion criteria, resulting in an overall attrition rate of 38%. Attrition could pose a risk to the internal validity of our treatment effects on vaccination inaction presented in chapter 4.3.2. In the following, we aim to identify whether there is a problem and, if so, the size of it. As a first step, we determine whether attrition rates are different across treatment and control groups. Fig. C.2 shows that attrition differs across groups. While there are no significant differences between attrition rates of the control group and both information treatments, participants in the facilitation group are about 6 percentage points less likely to return (T-Test diff. = -.062, t_{669} = -1.63, p = .103). While this does not necessarily threaten internal validity, it is more likely that participants in the facilitation treatment differ in baseline outcomes or important determinants of the outcome variable from the control group.

Fig. C.2 Differential attrition across treatments



Note: Shares by treatment group and 95% confidence intervals Plotted are the shares of participants who took part in both the survey experiment and follow-up survey for each treatment group.

In a second step, we analyze whether there is selective attrition, i.e., whether the mean of baseline outcomes differ between treatment groups for attritors and returners. Random assignment in the presence of attrition does not ensure that any differences between control and treatment groups can be attributed to the treatment. These comparisons are only unbiased if we were able to collect follow-up data for all participants from the survey experiment. To understand whether attrition affects the internal validity of our estimates, we compare the mean baseline outcomes across all four groups of participants by return status (Ghanem et al., 2021), see Table C.3. For baseline outcomes (inaction, intention, 5C), we find that returners and attritors have similar values across all four groups. Only returners in the debunking treatment have significantly lower values for the Calculation dimension of the 5C scale than control returners. On average across all groups, however,

there are some significant differences between returners and attritors, for example, baseline inaction is about 50% for attritors and 54% for returners. Also, attritors tend to have higher vaccination intentions than returners. This indicates that returning to the follow-up survey is correlated with other characteristics unobserved in our survey (or maybe even unobservable) that affect our outcome of interest. However, these differences are still independent of the treatment assignment within returners and within attritors. Thus, while our returner sample might not be representative of the study population from the survey experiment, our average treatment estimates are still internally valid for the returner population. While differences between treatments for attritors are not significant for our outcomes, there are not zero. For example, baseline inaction is 46% for control attritors but 56% for information treatment attritors. Due to these differences, we rather overestimate the effectiveness of our information treatments. To account for these imbalances, we control for interaction effects with baseline inaction in our analysis reported in section C.9.

Table C.3 Selective attrition across treatments

	Mean Baseline Outcomes by Group				Differences in means		
	Control	T1: Debunk	T2: Benefits	T3: Facili-tation			
	(1)	(2)	(3)	(4)	(1)-(2)	(1)-(3)	(1)-(4)
Panel A. Returners							
Vac. inaction	0.532	0.522	0.517	0.582	0.010	0.015	-0.050
Vac. intent mRNA	4.936	5.073	5.309	4.884	-0.137	-0.373	0.053
5C: Conf. mRNA	4.574	4.691	4.805	4.450	-0.117	-0.231	0.125
5C: Complacency	3.307	3.073	3.097	3.249	0.234	0.210	0.058
5C: Constraints	2.035	1.997	2.196	2.071	0.038	-0.162	-0.036
5C: Calculation	5.323	4.928	5.143	5.339	0.394***	0.179	-0.016
5C: Collective res.	5.005	4.920	5.116	4.921	0.084	-0.111	0.084
Observations	220	205	207	189			
Panel B. Attritors							
Vac. inaction	0.460	0.562	0.558	0.449	-0.102	-0.099	0.010
Vac. intent mRNA	5.387	5.273	5.233	5.493	0.114	0.154	-0.106
5C: Conf. mRNA	4.645	4.890	4.783	4.998	-0.245	-0.138	-0.352
5C: Complacency	3.274	3.186	3.371	2.978	0.088	-0.097	0.296
5C: Constraints	2.371	2.306	2.425	2.256	0.065	-0.054	0.115
5C: Calculation	4.777	4.895	5.008	4.966	-0.118	-0.231	-0.189
5C: Collective res.	5.070	5.088	5.067	5.348	-0.018	0.003	-0.278
Observations	124	121	122	138			

Notes: The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

C.6 Measurement details

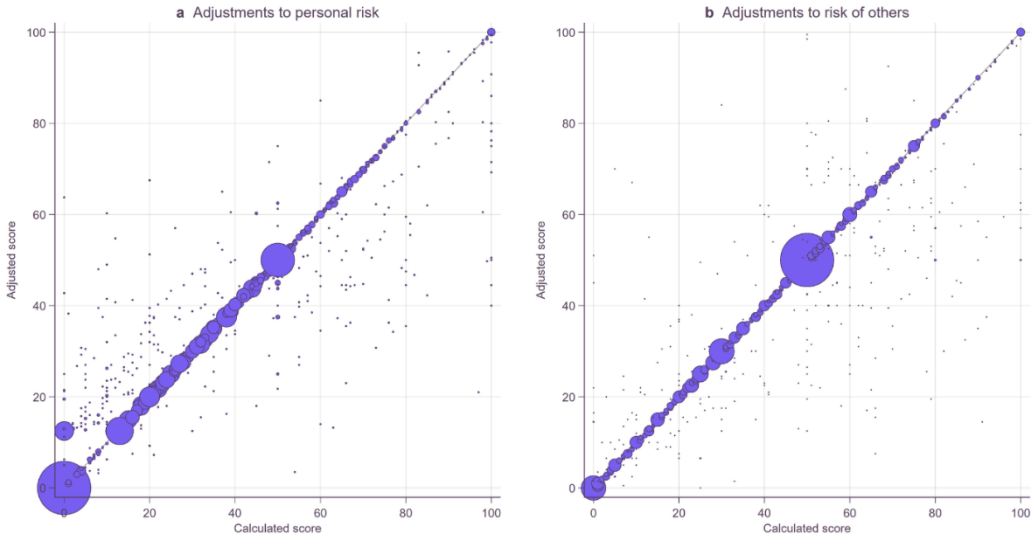
C.6.1 Risks to self and others: Calculated score and adjustment

Risk perception was assessed in three steps. First, we asked participants a series of questions about the likelihood of infection, the severity of the disease, and long-term consequences, such as long COVID ($\alpha = .71$). Based on these responses, we ranked their perception of risk to themselves and others on a scale from 0 “no risk” to 100 “high risk.”

Participants were then asked to correct their ratings if they felt misrepresented by it (see Fig. C.3 for adjustments made). Finally, the average of the two scores was taken to determine the risk perception score used in the analysis.

To elicit participants' risk perception of COVID-19 we asked participants how likely they think it is that they/others will get infected and severe an infection would be for themselves and others (see section C.12, question 1-3). From these answers, we calculated an index (unweighted mean) for risk appraisal of personal risk and risk for others presented to the participant. They then had the opportunity to adjust the risk appraisal for personal risk and risk for others. This procedure was chosen as we first wanted to guide participants towards factors we deemed relevant for the evaluation of risk appraisal but also to give them the chance to adjust their scores in case they felt misrepresented by the items we chose. Most participants made either small or no adjustments at all, with only 20% and 17% making changes greater than 20 of the calculated index for the personal risk and risk for others respectively. The correlation between the calculated score and the adjusted score is 0,71 ($p < .01$) for risk appraisal for oneself, and .83 ($p < .01$) for others. Fig. C.3 plots the calculated score against the adjusted score for personal risk (A) and risk for others (B).

Fig. C.3 Participants' adjustments to the calculated risk perception score



Note: Panel A shows the changes participants made to their personal risk perception score and panel B shows the adjustments made to participants' risk score for other people. Risk scores are calculated based on participants' responses. The calculated score that was shown to participants is plotted on the x-axis and the adjusted score on the y-axis. Observations that are to the left of the 45-degree line represent increases made by participants, and observations to the right represent decreases.

C.6.2 Need-Weighted net income approach

We follow the need-weighted net income approach (i.e., equivalent income) outlined by Niehues and Stockhausen (2019) taking into account that children need less money than adults and that life becomes cheaper when several people live together. Therefore, the total

monthly net household income is divided by the needs-weighted number of household members. The first adult has a factor of 1, each additional household member over 14 has a factor of .5, and children under 14 have a factor of .3.

C.7 Balancing and manipulation check

C.7.1 Survey Experiment

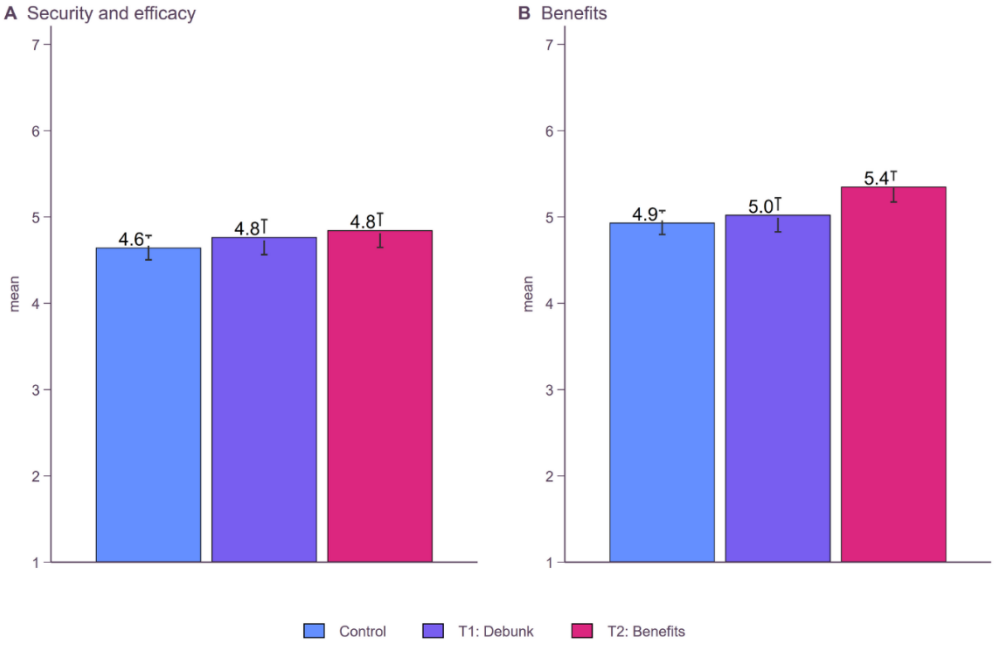
Participants were assigned to treatment groups randomly. Despite random assignment differences between groups may occur. We test for this possibility to see for which variables we should control in the estimations. As we do find differences in age, education, past vaccine denial, risk perception, and emotional response to COVID-19 across treatments we control for these variables in all estimations.

Table C.4 Balancing across treatments: Survey experiment

	(1)	(2)	(3)	t-test Difference	
	Control	Debunk	Benefits		
Variable	Mean/SE	Mean/SE	Mean/SE	(1)-(2)	(1)-(3)
Socio-economics					
Female (=1)	0.520	0.503	0.502	0.017	0.019
	[0.019]	[0.028]	[0.028]		
Age: 32-44 (=1)	0.200	0.215	0.196	-0.015	0.004
	[0.015]	[0.023]	[0.022]		
Age: 32-44 (=1)	0.128	0.123	0.131	0.005	-0.003
	[0.013]	[0.018]	[0.019]		
Age: 45-52 (=1)	0.215	0.193	0.251	0.021	-0.036
	[0.016]	[0.022]	[0.024]		
Age: 53-58 (=1)	0.380	0.356	0.367	0.024	0.013
	[0.019]	[0.027]	[0.027]		
Age: 59-81 (=1)	0.077	0.113	0.055	-0.036*	0.022
	[0.010]	[0.018]	[0.013]		
Secondary school:	0.133	0.098	0.089	0.034	0.044**
‘Hauptschulabschluss' (=1)	[0.013]	[0.017]	[0.016]		
Secondary school:	0.343	0.377	0.324	-0.035	0.019
'Realschuleabschluss' (=1)	[0.018]	[0.027]	[0.026]		
High school (=1)	0.273	0.282	0.309	-0.009	-0.036
	[0.017]	[0.025]	[0.026]		
University degree (=1)	0.252	0.242	0.278	0.010	-0.026
	[0.017]	[0.024]	[0.025]		
Adjusted HH income	3.951	4.098	4.054	-0.147	-0.102
	[0.069]	[0.100]	[0.100]		
Married (=1)	0.434	0.390	0.388	0.044	0.045
	[0.019]	[0.027]	[0.027]		
Explanatory variables					
Baseline: Vaccination inaction (=1)	0.516	0.537	0.532	-0.021	-0.016
	[0.019]	[0.028]	[0.028]		
Denied other vaccine (=1)	0.154	0.113	0.144	0.040*	0.010
	[0.014]	[0.018]	[0.019]		
Index: COVID-19 risk perception	41.171	37.523	37.674	3.648**	3.497**
	[0.900]	[1.202]	[1.171]		
Index: Emotional response	3.719	3.499	3.504	0.220**	0.215**
	[0.059]	[0.079]	[0.078]		
Net anticipated regret (no	0.817	1.104	1.073	-0.288	-0.257
vaccination – vaccination)	[0.151]	[0.227]	[0.225]		
Index: Dogmatism	3.934	4.002	3.948	-0.068	-0.014
	[0.037]	[0.053]	[0.053]		
Observations	671	326	327		
F-test of joint significance (F-stat)				1.804**	1.437
F-test, number of observations				997	998

Note: The value displayed for t-tests are the differences in the means across the groups. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Fig. C.4 Priming check: Variation in feeling informed



Note: Bars show mean values for each treatment group and 95% confidence intervals are indicated by lines. Panel A and B show the means towards the question "How informed do you feel about the safety and effectiveness of Corona vaccines?" and "How informed do you feel about the benefits for fully vaccinated individuals?" respectively. Answers were given on a 7-point Likert scale from 1 (not informed at all) to 7 (fully informed).

C.7.2 Balanced Panel

Table C.5 Balancing across treatments: Returners

	(1) Control	(2) T1: Debunk	(3) T2: Benefits	(4) T3: Facili..	T-Test Difference		
Variable	Mean/SE	Mean/SE	Mean/SE	Mean/SE	(1)-(2)	(1)-(3)	(1)-(4)
Female (=1)	0.482	0.473	0.527	0.513	0.009	-0.045	-0.031
	[0.034]	[0.035]	[0.035]	[0.036]			
Age: 32-44 (=1)	0.105	0.146	0.140	0.090	-0.042	-0.036	0.015
	[0.021]	[0.025]	[0.024]	[0.021]			
Age: 32-44 (=1)	0.109	0.107	0.097	0.122	0.002	0.012	-0.013
	[0.021]	[0.022]	[0.021]	[0.024]			
Age: 45-52 (=1)	0.236	0.166	0.271	0.185	0.071*	-0.034	0.051
	[0.029]	[0.026]	[0.031]	[0.028]			
Age: 53-58 (=1)	0.432	0.449	0.430	0.513	-0.017	0.002	-0.081
	[0.033]	[0.035]	[0.034]	[0.036]			
Age: 59-81 (=1)	0.118	0.132	0.063	0.090	-0.014	0.055**	0.028
	[0.022]	[0.024]	[0.017]	[0.021]			
Secondary school: 'Hauptschulabschluss' (=1)	0.127	0.112	0.077	0.169	0.015	0.050*	-0.042
	[0.023]	[0.022]	[0.019]	[0.027]			
Secondary school: 'Realschuleabschluss' (=1)	0.345	0.390	0.362	0.386	-0.045	-0.017	-0.041
	[0.032]	[0.034]	[0.033]	[0.036]			
High school (=1)	0.250	0.254	0.290	0.233	-0.004	-0.040	0.017
	[0.029]	[0.030]	[0.032]	[0.031]			
University degree (=1)	0.277	0.244	0.271	0.212	0.033	0.007	0.066
	[0.030]	[0.030]	[0.031]	[0.030]			
Adjusted HH income	3.972	4.015	4.109	4.034	-0.042	-0.137	-0.062

	[0.120]	[0.119]	[0.120]	[0.137]			
Married (=1)	0.500	0.434	0.440	0.460	0.066	0.060	0.040
	[0.034]	[0.035]	[0.035]	[0.036]			
Baseline: Vaccination inaction (=1)	0.532	0.522	0.517	0.582	0.010	0.015	-0.050
	[0.034]	[0.035]	[0.035]	[0.036]			
Denied other vaccine (=1)	0.155	0.122	0.130	0.148	0.033	0.024	0.006
	[0.024]	[0.023]	[0.023]	[0.026]			
Index: COVID-19 risk perception	40.827	36.324	37.493	38.558	4.503*	3.335	2.269
	[1.645]	[1.592]	[1.456]	[1.712]			
Index: Emotional response	3.599	3.460	3.524	3.617	0.139	0.075	-0.018
	[0.109]	[0.104]	[0.101]	[0.114]			
Net anticipated regret (no vaccination – vaccination)	0.586	1.141	1.111	0.566	-0.555	-0.525	0.020
	[0.271]	[0.310]	[0.279]	[0.300]			
Index: Dogmatism	3.912	4.068	3.989	4.051	-0.157	-0.078	-0.140
	[0.066]	[0.072]	[0.067]	[0.072]			
Observations	220	205	207	189			
F-test of joint significance (F-stat)					1.329	1.336	0.869
F-test, number of observations					425	427	409

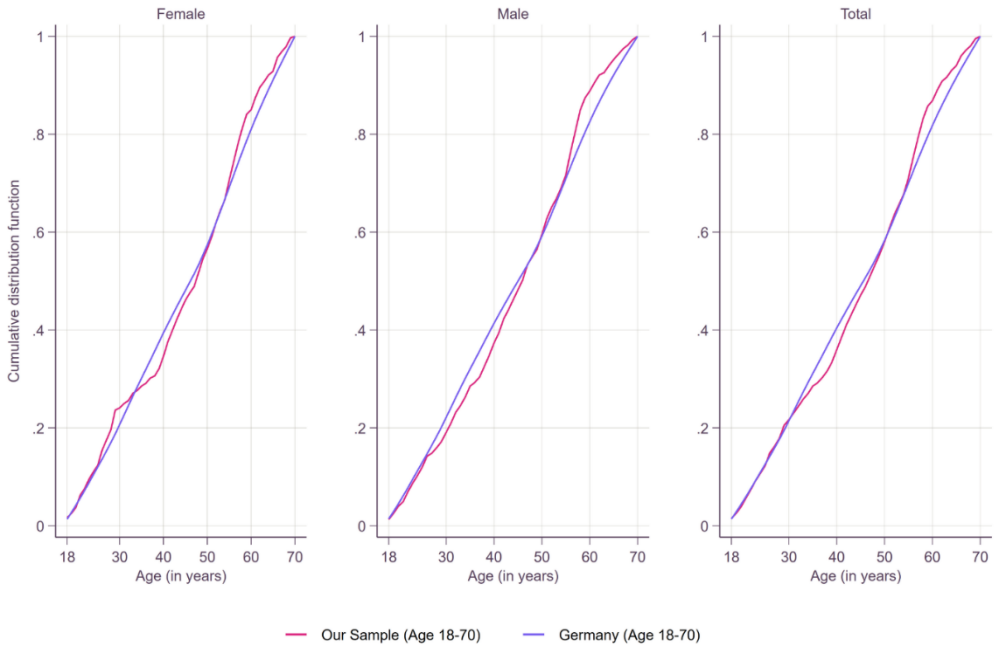
Notes: The dependent variable took the value of one when the participant was assigned to one of the treatments and zero when in control for each of the joint F-test of orthogonality.

C.8 Sample details

Participants were recruited from a general population panel in Germany by the survey company Respondi, which has mainly access to Germans between the age of 18-69 years. We aimed at a gender and age distribution similar to that of the German population within the accessible age bracket from 18-69. For targeting, we used the age distribution of the German population provided by the Statistische Bundesamt. We formed six age categories (18-25, 26-35, 36-45, 46-55, 55-69, 70, and above) for male and female participants respectively. Recruitment for a given age-gender combination was stopped once the target aimed for was reached.

In terms of gender, our sample is not statistically different from the age distribution in Germany in the age between 18 and 70. However, our final sample exceeds the German distribution in terms of people between 55 and 60 and we fall below the German distribution for those above 60. This is most likely to be explained by the fact, that we only allowed unvaccinated people to participate in a time when older people were more likely to be vaccinated due to vaccination priorities.

Fig. C.5 Age distribution: sample vs. census



Note: Comparison of cumulative age distribution in our sample to that of the German population. Where the inclination of our sample-line (blue) is greater than that of the German population-line (orange) age is oversampled.

Table C.6 Sample means vs. census data

Variable	Study sample			Germany
	N	Mean	SD	Mean
Age (18-70)	1,308	44.98	14.03	45.030
Female (18-70)	1,308	0.51	0.50	0.496
Abitur	1,324	0.54	0.50	0.335
Household Size				
Single	1,324	0.17	0.38	0.406
2 Person	1,324	0.32	0.47	0.34
3 Person	1,324	0.26	0.44	0.121
4 Person	1,324	0.13	0.33	0.098
5 Person or more	1,324	0.11	0.32	0.035

Notes: Summary of age, female, higher education (abitur), and household size of our sample and the German census. As our participants in our sample are mainly 18 to 70 years old we confine ourself to a comparison of our sample with the German population for that age bracket in terms of age and female. As we did not find age specific data fitting our dataset, we compare education (Abitur) and Household house for the full age distribution.

Table C.7 Study sample vs. unvaccinated population

Variable	Study sample		Unvaccinated population June 2, 2021	
	N	Percent	N	Percent
Age (18-59)	1,121	84.66%	27,276,784	82.72%
Age (60+)	203	15.34%	5,699,382	17.28%
Observations	1,324		32,976,166	

Notes: We compare our sample from June 2, 2021, to the unvaccinated population of Germany age 18 and above using publicly available vaccination data provided by the Robert Koch Institute (RKI) (https://raw.githubusercontent.com/robert-koch-institut/COVID-19-

Impfungen_in_Deutschland/master/Aktuell_Deutschland_Landkreise_COVID-19-Impfungen.csv") and the 2020 census data provided by the German Statistical Office (https://www-genesis.destatis.de/).

C.9 Additional results and robustness checks

This section provides additional results and robustness checks of our findings. The structure of this sections follows the outline of the main manuscript starting with the survey experiment, continuing with the findings from the balanced panel, and concluding with a detailed look at vaccination hesitancy.

C.9.1 Survey experiment

C.9.1.1 Vaccination intentions

Table C.8 Treatment effects vaccination intentions

		mRNA			Vector	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk	0.03	0.01	-0.02	0.16	0.11	0.06
	(0.16)	(0.16)	(0.10)	(0.16)	(0.15)	(0.13)
T2: Benefits	0.16	0.09	0.11	0.20	0.13	0.11
	(0.15)	(0.15)	(0.09)	(0.16)	(0.15)	(0.13)
Socio-economics						
Female (=1)		-0.22*	-0.11		-1.10***	-0.97***
		(0.13)	(0.08)		(0.13)	(0.11)
Age: 32-44 (=1)		-0.23	0.21		-0.34	-0.08
		(0.23)	(0.16)		(0.22)	(0.19)
Age: 45-52 (=1)		-0.10	-0.12		0.02	-0.00
		(0.20)	(0.12)		(0.20)	(0.17)
Age: 53-58 (=1)		-0.25	-0.13		0.04	0.10
		(0.19)	(0.12)		(0.19)	(0.16)
Age: 59-81 (=1)		-0.71**	-0.44***		0.06	0.20
		(0.31)	(0.16)		(0.29)	(0.23)
Secondary school: 'Realschulabschluss' (=1)		0.42*	0.28*		0.16	0.08
		(0.24)	(0.15)		(0.21)	(0.18)
High school (=1)		0.84***	0.31**		0.66***	0.30
		(0.25)	(0.15)		(0.22)	(0.18)
University degree (=1)		0.81***	0.19		0.85***	0.41**
		(0.25)	(0.16)		(0.23)	(0.19)
Adjusted HH income		0.08**	-0.01		0.08**	0.01
		(0.04)	(0.02)		(0.04)	(0.03)
Married (=1)		-0.09	-0.13		-0.15	-0.16
		(0.14)	(0.09)		(0.13)	(0.11)
Reasons						
Vaccination inaction (=1)			-1.10***			-0.66***
			(0.10)			(0.13)
Denied other vaccine (=1)			-0.53***			-0.27**
			(0.13)			(0.14)
Index: COVID-19 risk perception std.)			0.21***			-0.02
			(0.05)			(0.07)
Index: Emotional response (std.)			0.07			0.03
			(0.05)			(0.07)
Net anticipated regret (std.)			1.35***			1.01***
			(0.05)			(0.07)
Index: Dogmatism (std.)			-0.04			-0.02
			(0.04)			(0.06)

Constant	5.12***	4.58***	5.77***	3.23***	3.12***	3.89***
	(0.09)	(0.29)	(0.18)	(0.09)	(0.28)	(0.25)
Observations	1,324	1,324	1,324	1,324	1,324	1,324
R-squared	0.00	0.03	0.64	0.00	0.09	0.36
Adjusted R-squared	-0.001	0.025	0.640	0.000	0.080	0.349
F-test: Socio-economics		0.000	0.001		0.000	0.000
F-test: Reasons			0.000			0.000

Notes: The dependent variable is the intention to get vaccinated, separately for mRNA and vector vaccines, measured using a 7-point Likert scale. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

Table C.9 Heterogeneous treatments effects: mRNA

	Intention mRNA (1-7)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk	0.20**	0.07	0.15	0.12	-0.10	0.03
	(0.10)	(0.16)	(0.15)	(0.15)	(0.11)	(0.16)
T2: Benefits	-0.01	0.13	0.23	0.22	0.03	0.10
	(0.10)	(0.16)	(0.14)	(0.14)	(0.10)	(0.15)
Vaccination inaction (=1)	-2.68***					
	(0.15)					
T1 * Vaccination inaction	-0.23					
	(0.25)					
T2 * Vaccination inaction	0.28					
	(0.25)					
Denied other vaccines (=1)		-1.54***				
		(0.27)				
T1 * Denied		-1.06**				
		(0.50)				
T2 * Denied		-0.36				
		(0.47)				
Index: COVID-19 risk perception (std.)			0.89***			
			(0.08)			
T1 * Risk index			0.16			
			(0.14)			
T2 * Risk index			0.02			
			(0.14)			
Index: Emotional response (std.)				0.86***		
				(0.09)		
T1 * Emotional response				0.17		
				(0.15)		
T2 * Emotional response				-0.02		
				(0.15)		
Net anticipated regret (std.)					1.78***	
					(0.06)	
T1 * Net anticipated regret					0.01	
					(0.10)	
T2 * Net anticipated regret					0.05	
					(0.09)	
Index: Dogmatism (std.)						-0.15
						(0.10)
T1 * Dogmatism						-0.13
						(0.17)
T2 * Dogmatism						-0.15
						(0.15)
Constant	6.50***	4.81***	4.51***	4.59***	5.02***	4.61***
	(0.25)	(0.28)	(0.26)	(0.27)	(0.19)	(0.29)
Observations	1,324	1,324	1,324	1,324	1,324	1,324
Adjusted R-squared	0.35	0.10	0.18	0.16	0.58	0.03
Interaction: T1 sig.	0.000	0.000	0.000	0.000	0.000	0.099
Interaction: T2 sig.	0.000	0.000	0.000	0.000	0.000	0.025

Notes: The dependent variable is the intention to get vaccinated with a mRNA vaccine, measured using a 7-point Likert scale. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

Table C.10 Heterogeneous effects: Vector

	Intention Vector (1-7)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk	0.05	0.12	0.19	0.17	0.04	0.13
	(0.22)	(0.17)	(0.15)	(0.15)	(0.13)	(0.15)
T2: Benefits	-0.07	0.18	0.20	0.19	0.09	0.14
	(0.22)	(0.17)	(0.15)	(0.15)	(0.13)	(0.15)
Vaccination inaction (=1)	-1.88***					
	(0.16)					
T1 * Vaccination inaction	0.20					
	(0.28)					
T2 * Vaccination inaction	0.44					
	(0.28)					
Denied other vaccines (=1)		-0.98***				
		(0.22)				
T1 * Denied		-0.38				
		(0.37)				
T2 * Denied		-0.38				
		(0.35)				
Index: COVID-19 risk perception (std.)			0.44***			
			(0.08)			
T1 * Risk index			0.10			
			(0.15)			
T2 * Risk index			0.07			
			(0.14)			
Index: Emotional response (std.)				0.38***		
				(0.09)		
T1 * Emotional response				0.23		
				(0.16)		
T2 * Emotional response				0.28*		
				(0.15)		
Net anticipated regret (std.)					1.25***	
					(0.07)	
T1 * Net anticipated regret					-0.09	
					(0.12)	
T2 * Net anticipated regret					-0.05	
					(0.12)	
Index: Dogmatism (std.)						-0.15*
						(0.09)
T1 * Dogmatism						-0.02
						(0.16)
T2 * Dogmatism						0.06
						(0.15)
Constant	4.42***	3.27***	3.08***	3.13***	3.41***	3.14***
	(0.27)	(0.27)	(0.26)	(0.26)	(0.23)	(0.27)
Observations	1,324	1,324	1,324	1,324	1,324	1,324
Adjusted R-squared	0.21	0.11	0.12	0.12	0.33	0.08
Interaction: T1 sig.	0.000	0.000	0.000	0.000	0.000	0.194
Interaction: T2 sig.	0.000	0.000	0.000	0.000	0.000	0.266

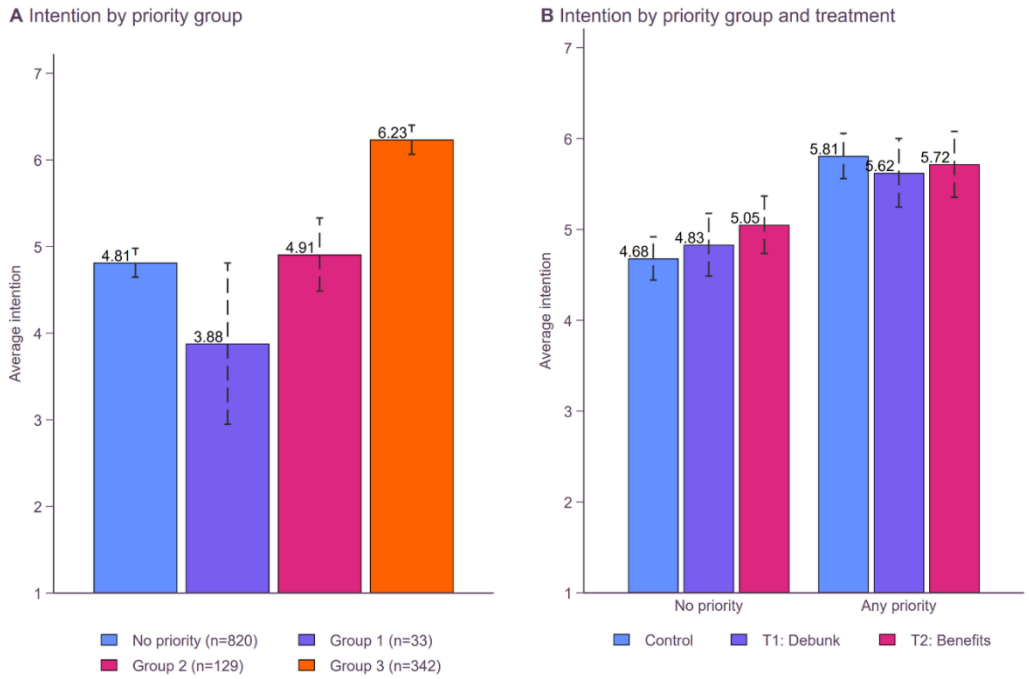
Notes: The dependent variable is the intention to get vaccinated with a vector vaccine, measured using a 7-point Likert scale. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

We thank an anonymous reviewer for the suggestion to investigate heterogeneous treatment effects depending on participants' priority group status. In Germany, vaccination priorities were ranked by age, medical condition, and profession (health care, nursing, etc.). At the time of the survey experiment, prioritization was lifted and all people above the age of 16 could apply for a vaccination appointment at vaccination centers or their general practitioner. Officially, vaccination prioritization ended in Germany on June 7th,

but because of the high demand, appointments were organized several weeks in advance. In our sample, 33 participants (2.5%) reported to be in the first prioritization group (highest priority), 129 (9.7%) in the second priority group (high priority), and 342 (25,8%) in the third group (increased priority). Thus, about 38% of participants in the survey experiment could potentially be more hesitant than the rest, because they already had the chance to get vaccinated, or at least to get an appointment, due to their priority status.

First, looking at how vaccination intentions vary across priority groups (see Fig. C.6A), we find that intentions are indeed slightly lower for participants in group 1 (the highest priority group) compared to participants without priority status (T-Test diff. = -.93, t_{851} = -2.15, p = .03). Importantly, participants in group 2 (high priority) have similar intentions (T-Test diff. = .09, t_{947} = .41, p = .68) and participants in group 3 (increased priority) even have significant higher intentions compared to participants without priority status (T-Test diff. = 1.42, $t_{1,160}$ = 9.96, p < .001). Second, we analyze whether participants respond differently to the treatments in the survey experiment depending on their priority status (see Fig. C.6B). Given the low number of observations in each treatment condition of participants in the first two priority groups, we opted for a binary specification of priority status (which equals 1 if a respondent is in priority group 1, 2, or 3 and equals 0 if a respondent has no priority status). We find that among the group of participants with priority status, intentions to get vaccinated are slightly higher in the benefits treatment compared to the control group (ß = .37, p = .07, 95%CI: -.03 to .77). In addition, we find that none of the treatments significantly affected vaccination intentions among participants with priority status. This could be seen as suggestive evidence that the benefits treatment increased vaccination intentions only among participants without priority status (but only at the 10% significance level). When controlling for the same set of covariates as in Table C.8 the effect is not statistically significant when we only include participants without priority status in the regression (see Table C.11, model 3).

Fig. C.6 Vaccination intentions



Note: Panel A shows average intentions to get vaccinated with an mRNA vaccine across priority groups. Panel B shows treatment effects by priority status with a binary specification that equals 1 if the participant reported being in one of the three priority groups and 0 otherwise. Dashed lines indicate 95% confidence intervals.

Taken together, these findings speak against our prior belief that unvaccinated participants with priority status are systematically more hesitant than the rest of the sample. It might be the case that participants with priority group status still faced barriers in getting their vaccination. For example, they might have struggled to make an appointment which often required either computer skills or waiting in long phone queues. Especially older participants, who predominantly made up the highest priority groups, might have struggled with this. In the survey experiment, 70% of participants with priority status reported that they have a vaccination appointment (27%) or are on a waiting list (43%). Thus, it seems that most participants with priority status in our sample only have or had to delay their vaccination but were still getting their vaccination faster than participants without the priority status (only 8% of them had an appointment and 26% were on a waiting list).

Table C.11 Treatment effects vaccination intentions: Only respondents without prioritization status

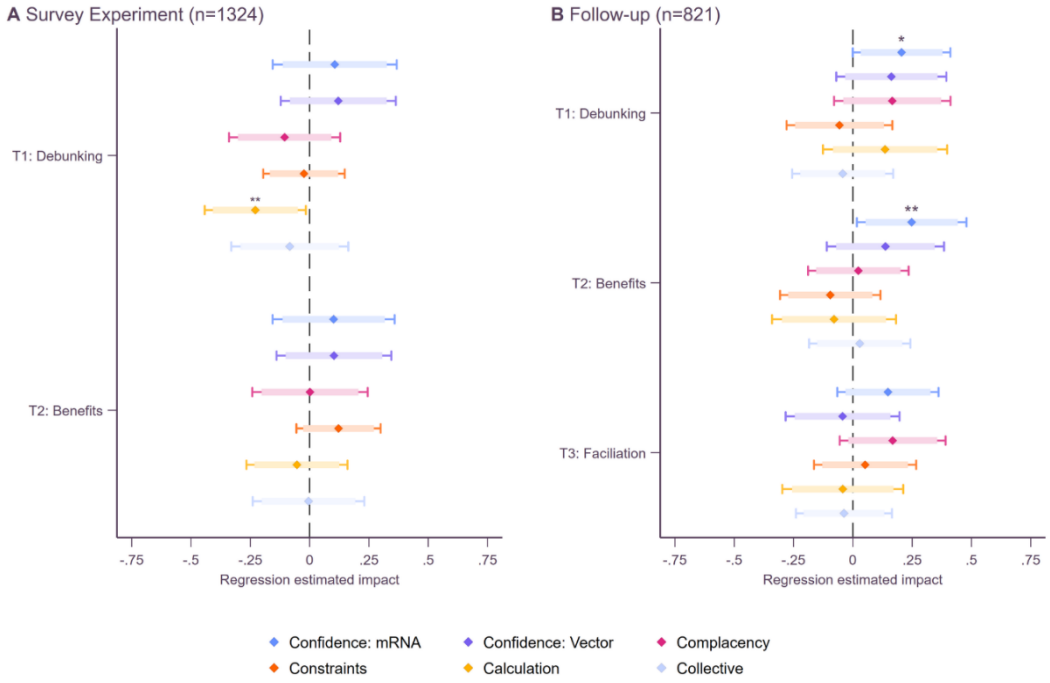
		mRNA	
VARIABLES	(1)	(2)	(3)
T1: Debunk	0.15	0.11	0.03
	(0.21)	(0.21)	(0.13)
T2: Benefits	0.37*	0.30	0.19
	(0.20)	(0.20)	(0.12)
Socio-economics			
Female (=1)		-0.23	-0.16
		(0.17)	(0.11)
Age: 32-44 (=1)		-0.49*	0.03
		(0.29)	(0.21)
Age: 45-52 (=1)		-0.35	-0.25

		(0.26)	(0.16)
Age: 53-58 (=1)		-0.52**	-0.29*
		(0.24)	(0.16)
Age: 59-81 (=1)		-1.97***	-0.78***
		(0.42)	(0.27)
Secondary school: 'Realschulabschluss' (=1)		0.48	0.17
		(0.31)	(0.20)
High school (=1)		0.80**	0.18
		(0.32)	(0.21)
University degree (=1)		0.93***	0.07
		(0.32)	(0.21)
Adjusted HH income		0.05	-0.02
		(0.05)	(0.03)
Married (=1)		-0.10	-0.17
		(0.19)	(0.12)
Reasons			
Vaccination inaction (=1)			-0.92***
			(0.12)
Denied other vaccine (=1)			-0.55***
			(0.18)
Index: COVID-19 risk perception std.)			0.23***
			(0.07)
Index: Emotional response (std.)			0.08
			(0.07)
Net anticipated regret (std.)			1.40***
			(0.06)
Index: Dogmatism (std.)			-0.03
			(0.05)
Constant	4.68***	4.48***	5.90***
	(0.12)	(0.37)	(0.25)
Observations	820	820	820
R-squared	0.00	0.06	0.64
Adjusted R-squared	0.002	0.048	0.628
F-test: Socio-economics		0.000	0.007
F-test: Reasons			0.000

Notes: The dependent variable is the intention to get vaccinated, separately for mRNA and vector vaccines, measured using a 7-point Likert scale. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

C.9.1.2 Psychological antecedents of vaccination (5C)

Fig. C.7 Treatment effects on 5c



Note: Panel A shows regression estimates with each 5C factor as the dependent variable in the survey experiment. Panel B shows the results on each 5C factor in the follow-up survey. Estimates are obtained from linear probability models controlling for gender, age, education, adjusted household income, and marital status. Heteroskedasticity robust standard errors were used to compute 95% (thin bars) and 90% (thick bars) confidence intervals.

Table C.12 Treatment effects on 5C: Wave 1

VARIABLES	mRNA Confidence (1)	Vector Confidence (2)	Complacency (3)	Constraints (4)	Calculation (5)	Collective (6)
T1: Debunking (=1)	0.11	0.12	-0.11	-0.02	-0.23**	-0.08
	(0.13)	(0.12)	(0.12)	(0.09)	(0.11)	(0.13)
T2: Benefits (=1)	0.10	0.10	0.00	0.12	-0.05	-0.00
	(0.13)	(0.12)	(0.12)	(0.09)	(0.11)	(0.12)
Socio-economics:						
Female (=1)	-0.30***	-0.53***	-0.13	-0.22***	0.17*	-0.01
	(0.11)	(0.10)	(0.10)	(0.07)	(0.09)	(0.10)
Age: 32-44 (=1)	-0.54***	-0.39**	0.22	-0.35**	0.28*	-0.21
	(0.19)	(0.18)	(0.18)	(0.14)	(0.16)	(0.18)
Age: 45-52 (=1)	-0.43***	-0.04	-0.25	-0.35***	0.40***	0.11
	(0.17)	(0.16)	(0.16)	(0.13)	(0.14)	(0.16)
Age: 53-58 (=1)	-0.54***	-0.16	-0.50***	-0.77***	0.55***	0.13
	(0.16)	(0.15)	(0.14)	(0.11)	(0.13)	(0.14)
Age: 59-81 (=1)	-0.76***	-0.40*	-0.17	-0.99***	0.68***	-0.09
	(0.25)	(0.24)	(0.23)	(0.14)	(0.19)	(0.24)
Secondary school (=1)	0.24	0.20	0.11	-0.22*	0.12	0.01
	(0.20)	(0.18)	(0.17)	(0.13)	(0.16)	(0.18)
High school (=1)	0.64***	0.71***	-0.27	-0.31**	0.22	0.44**
	(0.21)	(0.19)	(0.18)	(0.13)	(0.16)	(0.19)
University degree (=1)	0.73***	0.91***	-0.14	-0.20	0.26	0.47**
	(0.21)	(0.19)	(0.18)	(0.14)	(0.17)	(0.19)
Adjusted HH income	0.06**	0.04	-0.03	-0.03	-0.04*	0.06**
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Married (=1)	-0.00	-0.07	0.15	0.02	0.08	-0.03
	(0.12)	(0.11)	(0.11)	(0.08)	(0.09)	(0.11)
Constant	4.53***	3.64***	3.63***	3.06***	4.66***	4.56***
	(0.24)	(0.23)	(0.21)	(0.17)	(0.20)	(0.22)

Observations	1,324	1,324	1,324	1,324	1,324	1,324
Adjusted R-squared	0.04	0.06	0.02	0.06	0.02	0.01
F-Test: Socio-economics	0.000	0.000	0.000	0.000	0.001	0.001

Notes: The dependent variable are the 5C factors, measured using several 7-point Likert items in the survey experiment. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

Table C.13 Treatment effects on 5C: Wave 2

VARIABLES	mRNA Confidence (1)	Vector Confidence (2)	Complacency (3)	Constraints (4)	Calculation (5)	Collective (6)
T1: Debunking (=1)	0.21*	0.16	0.17	-0.06	0.14	-0.04
	(0.10)	(0.12)	(0.12)	(0.11)	(0.13)	(0.11)
T2: Benefits (=1)	0.25**	0.14	0.02	-0.10	-0.08	0.03
	(0.12)	(0.13)	(0.11)	(0.11)	(0.13)	(0.11)
T3: Facilitation (=1)	0.15	-0.04	0.17	0.05	-0.04	-0.04
	(0.11)	(0.12)	(0.11)	(0.11)	(0.13)	(0.10)
Baseline: Outcome	0.87***	0.84***	0.78***	0.46***	0.55***	0.80***
	(0.02)	(0.02)	(0.02)	(0.05)	(0.04)	(0.02)
Socio-economics:						
Female (=1)	-0.01	-0.02	-0.03	-0.18**	0.21**	0.12
	(0.08)	(0.09)	(0.08)	(0.08)	(0.10)	(0.08)
Age: 32-44 (=1)	0.12	-0.18	-0.18	-0.17	0.21	0.09
	(0.16)	(0.18)	(0.21)	(0.20)	(0.19)	(0.17)
Age: 45-52 (=1)	0.10	-0.06	-0.25	-0.41***	0.27	0.24*
	(0.14)	(0.17)	(0.16)	(0.16)	(0.17)	(0.14)
Age: 53-58 (=1)	0.15	-0.01	-0.21	-0.38***	0.44***	0.24*
	(0.13)	(0.16)	(0.16)	(0.14)	(0.15)	(0.13)
Age: 59-81 (=1)	0.16	0.12	-0.15	-0.16	0.25	0.35**
	(0.17)	(0.20)	(0.21)	(0.20)	(0.22)	(0.16)
Secondary school (=1)	-0.02	-0.20	-0.26*	0.14	0.22	0.09
	(0.13)	(0.15)	(0.15)	(0.13)	(0.18)	(0.13)
High school (=1)	0.14	-0.12	-0.24	0.18	0.43**	0.15
	(0.14)	(0.17)	(0.17)	(0.14)	(0.19)	(0.14)
University degree (=1)	0.19	-0.17	-0.35**	0.14	0.42**	0.20
	(0.14)	(0.17)	(0.16)	(0.14)	(0.19)	(0.14)
Adjusted HH income	0.01	-0.02	-0.00	-0.00	0.04*	-0.04**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Married (=1)	0.11	0.06	-0.01	-0.01	0.06	-0.05
	(0.08)	(0.09)	(0.09)	(0.09)	(0.10)	(0.08)
Constant	0.19	0.99***	1.07***	1.09***	1.40***	1.01***
	(0.21)	(0.24)	(0.26)	(0.22)	(0.29)	(0.21)
Observations	821	821	821	821	821	821
Adjusted R-squared	0.72	0.63	0.60	0.23	0.32	0.66
F-Test: Socio-economics	0.459	0.591	0.740	0.037	0.005	0.325

Notes: The dependent variable are the 5C factors, measured using several 7-point Likert items in the follow-up survey. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

C.9.1.3 Main result without exclusion of participants

As a relatively high share of participants had to be excluded from the analysis due to data quality issues and as those excluded do differ from those not excluded (see C.4 supplementary materials), we decided to run the main regressions again without exclusions. Leaving all observations in the sample does not affect the results obtained for the regression of intention to get vaccinated on treatments as shown in Table C.14. We report only the main results here, i.e. the effect of treatments on the vaccination intention.

Further analysis testing the effects of heterogeneous effects and the effect of the treatments on the 5Cs have been carried out for the sample without exclusions as well. We also tested if excluded participants reacted differently to the treatments by interacting treatment dummies with the exclusion dummy. For all these tests, the results do not change coefficients sign or statistical significance. Results are not reported here but can be received upon request.

Table C.14 Treatment effects vaccination intentions (without exclusion)

		mRNA			Vector	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	-0.01	-0.01	-0.05	0.11	0.07	0.01
T1: Debunk	(0.15)	(0.15)	(0.09)	(0.14)	(0.14)	(0.12)
	0.18	0.11	0.13	0.10	0.04	0.03
T2: Benefits	(0.14)	(0.14)	(0.09)	(0.15)	(0.14)	(0.12)
Socio-economics						
Female (=1)		-0.12	-0.02		-1.08***	-0.97***
		(0.12)	(0.08)		(0.11)	(0.10)
Age: 32-44 (=1)		-0.07	0.25*		-0.28	-0.10
		(0.20)	(0.14)		(0.19)	(0.16)
Age: 45-52 (=1)		0.10	0.02		-0.11	-0.18
		(0.18)	(0.12)		(0.18)	(0.15)
Age: 53-58 (=1)		-0.13	-0.04		-0.12	-0.09
		(0.18)	(0.11)		(0.17)	(0.14)
Age: 59-81 (=1)		-0.58**	-0.40**		-0.12	-0.06
		(0.28)	(0.16)		(0.26)	(0.21)
Secondary school: 'Realschulabschluss' (=1)		0.35	0.22		0.06	-0.01
		(0.22)	(0.13)		(0.19)	(0.16)
High school (=1)		0.78***	0.27*		0.57***	0.23
		(0.22)	(0.14)		(0.20)	(0.17)
University degree (=1)		0.67***	0.11		0.70***	0.32*
		(0.23)	(0.14)		(0.21)	(0.18)
Adjusted HH income		0.10***	0.01		0.08**	0.02
		(0.03)	(0.02)		(0.04)	(0.03)
Married (=1)		-0.10	-0.17**		-0.01	-0.06
		(0.13)	(0.08)		(0.12)	(0.11)
Reasons						
Vaccination inaction (=1)			-1.06***			-0.69***
			(0.09)			(0.12)
Denied other vaccine (=1)			-0.47***			-0.19
			(0.12)			(0.13)
Index: COVID-19 risk perception std.)			0.19***			-0.05
			(0.05)			(0.06)
Index: Emotional response (std.)			0.10**			0.08
			(0.05)			(0.07)
Net anticipated regret (std.)			1.31***			0.96***
			(0.05)			(0.06)
Index: Dogmatism (std.)			-0.02			0.05
			(0.04)			(0.05)
Constant	5.04***	4.35***	5.55***	3.29***	3.28***	4.08***
	(0.08)	(0.26)	(0.17)	(0.08)	(0.24)	(0.22)
Observations	1,532	1,531	1,531	1,532	1,531	1,531
R-squared	0.00	0.03	0.62	0.00	0.09	0.35
Adjusted R-squared	0.00	0.02	0.61	0.00	0.08	0.34
F-test: Socio-economics		0.00	0.00		0.00	0.00
F-test: Reasons			0.00			0.00

Notes: The dependent variable is the intention to get vaccinated, separately for mRNA and vector vaccines, measured using a 7-point Likert scale. Estimates are obtained from multiple least square regressions with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1.

C.9.2 Vaccination (in)action

Table C.15 Treatment effects on inaction: Balanced Panel

	Wave 2: Vaccination inaction (=1)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk (=1)	-0.03	-0.03	-0.01	0.00	-0.00	0.03
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.03)
T2: Benefits (=1)	-0.08**	-0.08**	-0.06*	0.01	0.03	0.04
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.03)
T3: Facilitator (=1)	-0.05	-0.05	-0.04	-0.01	-0.01	-0.01
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.03)
Baseline: Vaccination inaction (=1)	0.49***	0.48***	0.26***	0.56***	0.56***	0.34***
	(0.02)	(0.02)	(0.03)	(0.05)	(0.05)	(0.05)
Interactions:						
T1 * Baseline				-0.05	-0.05	-0.08
				(0.07)	(0.07)	(0.06)
T2 * Baseline				-0.17**	-0.19***	-0.19***
				(0.07)	(0.07)	(0.07)
T3 * Baseline				-0.07	-0.08	-0.05
				(0.07)	(0.07)	(0.06)
Constant	0.06**	0.09	0.18***	0.02	0.05	0.14**
	(0.02)	(0.07)	(0.06)	(0.01)	(0.06)	(0.06)
Socio-economics	N	Y	Y	N	Y	Y
Other reasons	N	N	Y	N	N	Y
Observations	821	821	821	821	821	821
R-squared	0.30	0.31	0.44	0.30	0.32	0.45

Notes: Linear probability model with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1

Table C.16 Robustness check using non-linear Probit models and computing margins

	Wave 2: Vaccination inaction (=1)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk (=1)	-0.02	-0.03	-0.02			
	(0.04)	(0.04)	(0.03)			
T2: Benefits (=1)	-0.07**	-0.08**	-0.07**			
	(0.04)	(0.04)	(0.03)			
T3: Facilitator (=1)	-0.05	-0.05	-0.03			
	(0.04)	(0.04)	(0.03)			
Baseline: Vaccination inaction (=1)	0.49***	0.49***	0.27***			
	(0.02)	(0.02)	(0.03)			
Interactions:						
T1 * Baseline				-0.05	-0.06	-0.07
				(0.07)	(0.07)	(0.08)
T2 * Baseline				-0.17**	-0.19***	-0.17**
				(0.07)	(0.07)	(0.07)
T3 * Baseline				-0.07	-0.08	-0.04
				(0.07)	(0.07)	(0.07)
Socio-economics	N	Y	Y	N	Y	Y
Other reasons	N	N	Y	N	N	Y
Pseudo R-squared	0.30	0.31	0.45	0.30	0.32	0.45
Observations	821	821	821	821	821	821

Notes: Non-linear probability model using Probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1

Table C.17 Robustness check linear model (without exclusion)

	Wave 2: Vaccination inaction (=1)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk (=1)	-0.01	-0.01	-0.01	0.01	0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
T2: Benefits (=1)	-0.08**	-0.08**	-0.08**	0.02	0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
T3: Facilitator (=1)	-0.05	-0.05	-0.05	0.01	0.00	0.00
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Baseline: Vaccination inaction (=1)	0.48***	0.47***	0.47***	0.56***	0.56***	0.56***
Interactions:	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
T1 * Baseline				-0.03	-0.03	-0.03
				(0.06)	(0.06)	(0.06)
T2 * Baseline				-0.19***	-0.21***	-0.21***
				(0.06)	(0.06)	(0.06)
T3 * Baseline				-0.10	-0.11*	-0.11*
				(0.06)	(0.06)	(0.06)
Constant	0.06***	0.07	0.07	0.02	0.03	0.03
	-0.01	-0.01	-0.01	0.01	0.01	0.01
Socio-economics	N	Y	Y	N	Y	Y
Other reasons	N	N	Y	N	N	Y
Observations	987	986	986	987	986	986
R-squared	0.29	0.30	0.30	0.29	0.31	0.31

Notes: Linear probability model with robust standard errors in parentheses: *** p<.01, ** p<.05, * p<.1

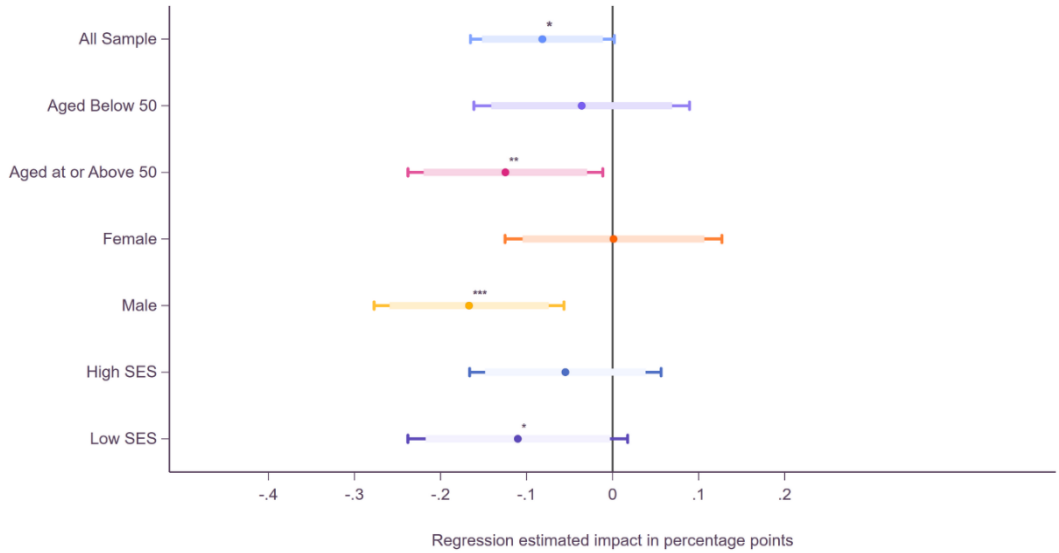
Table C.18 Heterogeneous treatment effects as pre-registered

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
T1: Debunk	-0.00	-0.05	-0.06	-0.04	0.00	-0.05
	(0.02)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
T2: Benefits	0.03	-0.09**	-0.10**	-0.09**	-0.05	-0.09**
	(0.02)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
T3: Facilitation	-0.01	-0.04	-0.04	-0.02	-0.02	-0.04
	(0.02)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
Interactions with baseline values						
Vaccination inaction (=1)	0.57***					
	(0.05)					
T1 * Vaccination inaction	-0.05					
	(0.07)					
T2 * Vaccination inaction	-0.20***					
	(0.07)					
T3 * Vaccination inaction	-0.07					
	(0.07)					
Denied other vaccines (=1)		0.18*				
		(0.10)				
T1 * Denied		0.19				
		(0.14)				
T2 * Denied		0.10				
		(0.14)				
T3 * Denied		0.12				
		(0.14)				
Index: COVID-19 risk perception (std.)			-0.14***			
			(0.03)			
T1 * Risk index			-0.01			
			(0.04)			
T2 * Risk index			0.03			
			(0.04)			
T3 * Risk index			-0.00			
			(0.04)			
Index: Emotional response (std.)				-0.13***		
				(0.03)		
T1 * Emotional response				0.00		
				(0.04)		

T2 * Emotional response				0.01		
				(0.04)		
T3 * Emotional response				-0.03		
				(0.04)		
Net anticipated regret (std.)					-0.28***	
					(0.02)	
T1 * Net anticipated regret					0.01	
					(0.03)	
T2 * Net anticipated regret					0.03	
					(0.03)	
T3 * Net anticipated regret					-0.01	
					(0.03)	
Index: Dogmatism (std.)						0.09***
						(0.03)
T1 * Dogmatism						-0.00
						(0.04)
T2 * Dogmatism						-0.06
						(0.04)
T3 * Dogmatism						-0.08
						(0.05)
Constant	0.07	0.46***	0.48***	0.45***	0.39***	0.48***
	(0.06)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)
Controls: PAP	Y	Y	Y	Y	Y	Y
Observations	821	821	821	821	821	821
Adjusted R-squared	0.30	0.05	0.10	0.10	0.37	0.03
Interaction: T1 sig.	0.00	0.00	0.00	0.00	0.00	0.00
Interaction: T2 sig.	0.00	0.00	0.00	0.00	0.00	0.01
Interaction: T3 sig.	0.00	0.00	0.00	0.00	0.00	0.05

Notes The table shows coefficient estimates from linear probability models of the outcome variable (inaction) on each treatment condition including interactions with the pre-registered measures with heteroskedasticity robust standard errors in parentheses (*** p<.01, ** p<.05, * p<.1). Additional controls as specified in the PAP are gender, age, education, adjusted household income and marital status.

Fig. C.8 Benefits treatment effects on inaction across socioeconomic groups



Note: The figure shows treatment effects of highlighting benefits across sociodemographic groups, for the entire sample, and separately based on sociodemographic factors. Estimates are always obtained from linear probability models controlling for gender, age, education, adjusted household income, and marital status. Heteroskedasticity robust standard errors were used to compute 95% (thin bars) and 90% (thick bars) confidence intervals.

Table C.19 Determinants of inaction in wave 2

	Vaccination inaction **(=1)**			
VARIABLES	(1)	(2)	(3)	(4)
T1: Debunking (=1)	-0.05	-0.05	-0.06	-0.06
	(0.07)	(0.07)	(0.06)	(0.06)
T2: Benefits (=1)	-0.16**	-0.18**	-0.13**	-0.13**
	(0.07)	(0.07)	(0.06)	(0.06)
T3: Facilitator (=1)	-0.08	-0.09	-0.08	-0.08
	(0.07)	(0.07)	(0.06)	(0.06)
Socio-economics:				
Female (=1)		0.12**	0.03	0.03
		(0.05)	(0.04)	(0.04)
Age: 30-39 (=1)		-0.05	-0.21**	-0.22**
		(0.10)	(0.09)	(0.10)
Age: 40-49 (=1)		-0.07	-0.16**	-0.16**
		(0.09)	(0.08)	(0.08)
Age: 50-64 (=1)		-0.03	-0.14*	-0.15*
		(0.08)	(0.08)	(0.08)
Age: 65+ (=1)		0.08	-0.13	-0.14
		(0.10)	(0.09)	(0.10)
Secondary school (=1)		-0.04	-0.02	-0.01
		(0.08)	(0.06)	(0.06)
High school (=1)		-0.10	-0.01	0.01
		(0.08)	(0.07)	(0.07)
University degree (=1)		-0.15*	-0.06	-0.05
		(0.09)	(0.07)	(0.07)
Adjusted HH income		-0.02	-0.01	-0.01
		(0.01)	(0.01)	(0.01)
Married (=1)		0.03	0.00	-0.00
		(0.05)	(0.04)	(0.04)
Baseline: Five C				
Confidence: MRNA			-0.10***	-0.10***
			(0.02)	(0.02)
Confidence: VECTOR			0.01	0.01
			(0.03)	(0.03)
Complacency			-0.03*	-0.03*
			(0.01)	(0.02)
Constraints			0.01	0.01
			(0.02)	(0.02)
Calculation			0.04***	0.04**
			(0.02)	(0.02)
Collective			-0.07***	-0.07***
			(0.02)	(0.02)
Reasons				
Denied other vaccine (=1)				-0.06
				(0.06)
Index: COVID-19 risk perception std.)				0.00
				(0.03)
Index: Emotional response (std.)				0.00
				(0.03)
Net anticipated regret (std.)				-0.02
				(0.04)
Index: Dogmatism (std.)				0.03
				(0.02)
Constant	0.58***	0.68***	1.23***	1.25***
	(0.05)	(0.12)	(0.16)	(0.17)
Observations	441	441	441	441
R-squared	0.01	0.06	0.38	0.38
Adjusted R-squared	0.007	0.027	0.352	0.348
F-Test: Treatments	0.108	0.073	0.173	0.205
F-Test: Socio-economics		0.030	0.352	0.381
F-Test: 5C			0.000	0.000
F-Test: Reasons				0.760

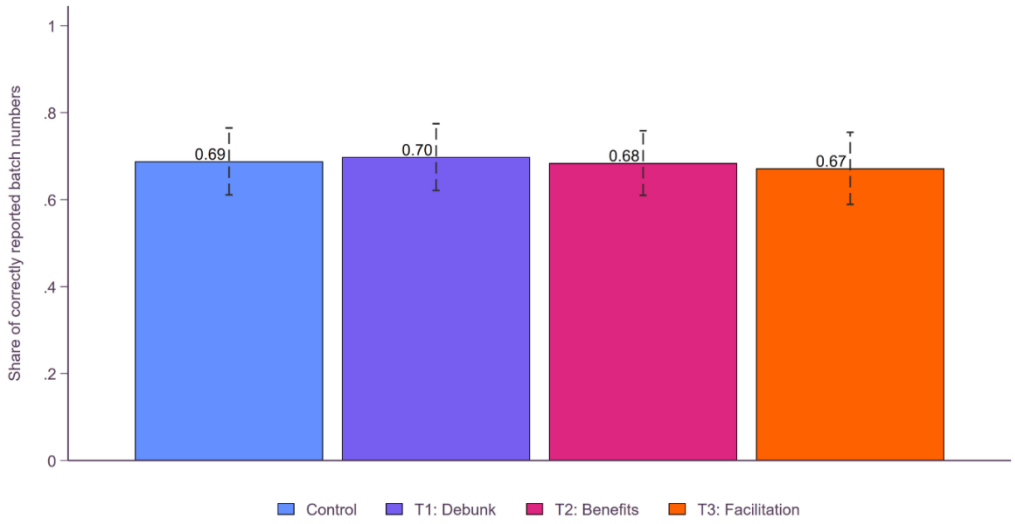
Notes: The table shows estimates from linear probability models with inaction as the outcome variable for the subsample of participants that had not taken any actions in the survey experiment. Heteroskedasticity robust standard errors in parentheses (*** p<.01, ** p<.05, * p<.1).

C.10 Demand Effects

In the follow-up survey, we asked participants who stated that they have been vaccinated once or twice to type in the batch number recorded in their vaccination pass/certificate. Since the survey took place during the time of vaccinations, we assumed participants to have their vaccination pass/certificate in reach. However, not all stated their batch correctly. As no list of batch numbers was available to us, we classified batches as correct or incorrect by the appearance. The logic behind this is that if the higher vaccination rate found in the benefits treatment was indeed due to demand effects, this should also reflect in the batches recorded – i.e., a higher share in the benefits treatment should report correct batch numbers.

On average, of the 557 participants vaccinated once or twice 69% percent reported a correct batch. We do not find a difference of batches reported correctly between treatments (see Fig. C.9).

Fig. C.9 Share of batch numbers correctly reported by treatment

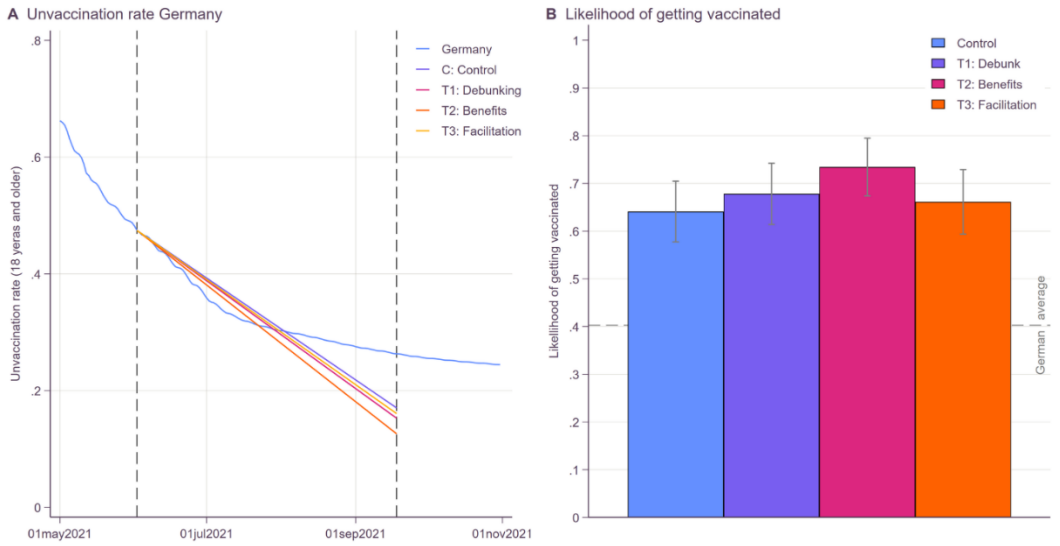


Note: Means by treatment group and 95% confidence intervals.

C.11 External validity

Throughout all treatments, study participants were more likely to get vaccinated within the study period of May 2 and September 18. While this does not affect the internal validity of our results it does make it more difficult to extrapolate our results to the general public.

Fig. C.10 Likelihood of getting vaccinated between May 2 and September 18



Note: Panel A, shows the unvaccinated rate of Germans 18 years and older compared to rates in our study sample for each treatment group. Panel B compares the likelihood of getting vaccinated between May 2 and September 18 for each treatment group. The average likelihood for Germans 18 years and older is indicated by the gray dotted line.

C.12 Experimental materials

In the following, we present the instructions from the survey as well as the emails sent to the three treatment conditions. The survey and emails were sent in German. An English translation of the text is provided below.

C.12.1 Welcome page and consent form

The text was used for both surveys with the exception of the confirmation of not being vaccinated which was only included in the first survey in May 2021. The welcome page and consent form read as follows:

> Dear Participants,
>
> this survey is part of a research study conducted by Matthias Mayer and colleagues from the University of Marburg. With the survey, we are trying to assess the attitude of the German population towards the topic of corona vaccination.
>
> You should know the following points about the study procedure:
>
> - The survey will take approximately 15 minutes to complete.
> - If you participate in this study, we will invite you to up to two further surveys.
> - Between these surveys, we will send you up to four emails via Respondi AG. Your email address will not be shared with us.
>
> The guidelines of good ethical research require that participants in empirical studies explicitly and comprehensibly agree to participate.
>
> **Voluntariness:** Your participation in this study is voluntary. You are free to discontinue your participation at any time during this study.
>
> **Benefits**: You may not derive any personal benefit from your participation in this study, but the knowledge you obtain may be of value to humanity.
>
> **Compensation**: You will be compensated by Respondi AG for your participation in this survey.

Anonymity: Your data is of course confidential, will only be evaluated in anonymous form and will not be passed on to third parties. Demographic information such as age or gender does not allow any clear conclusion to be drawn about your person.

Questions: If you have any further questions about this study, please feel free to contact the study director Max Burger at any time (maximilian.burger@wiwi.uni-marburg.de).

I hereby confirm that I ...

- am 18 years of age or older (y/n)
- have not received any Corona vaccination so far (neither fully nor partially vaccinated) (y/n)
- agree to receive up to four emails as part of this research project. (y/n)
- have read and understand the above information. (y/n)
- wish to participate in this research and proceed with the survey. (y/n)

C.12.2 Survey items

For full transparency and to enable replication we provide all survey items that were used for the main variables of interest. Items have been translated from German to English. All survey items are listed in the order they were recorded in the survey. All items are identical in both surveys in May and September 2021, except for the treatment material which was only included in the first survey in May.

C.12.2.1 Awareness: Fear of getting infected / consequences of an infection

1. **How likely do you think it is that you will be infected with Corona?**
   Please indicate how likely you think it is that you and others will become infected with Corona.
   [Slider: Low 0% |---| 100% High]
   How likely do you think it is that...
   ... you will become infected with Corona?
   ... one of your friends or family members will become infected with Corona?
   ... the average German becomes infected with Corona?

2. **How severe do you think the effects of Corona would be in your case if you were infected?**
   Please indicate how severe you think the consequences of being infected with Corona would be.
   [Single Choice]
   [ ] No symptoms
   [ ] Mild symptoms (e.g. symptoms similar to a severe cold or flu)
   [ ] Severe symptoms (e.g. acute respiratory distress requiring medical treatment)

3. **How would you rate the likelihood that...** *[Slider: Low 0% |---| 100% High]*
   ...you would suffer long-term consequences after recovering from Corona?
   ...you would die from Corona if you became infected?

4. **Self-evaluation**
   Based on your previous answers, we have summarized your risk assessment in a number. A high number (100) means "I rate Corona as a very high risk to me / society". A low number (0) "I rate Corona as no risk to me / others". The sliders on the scales rest on the values calculated for you.

   If you wish, you can change the values we have calculated according to your assessment. If you agree with the estimation, you can leave it where it rests.

   Own risk: <VALUE1>
   [Slider: No risk to me 0% |---| 100% high risk to me]

   Risk to others: <VALUE2>
   [Slider: No risk to others 0% |---| 100% high risk to others]

5. **What emotions does the thought of the Corona pandemic evoke in you?**
   In the following, we would like to know from you what emotions are triggered in you when you think about the Corona pandemic. Please go through the emotions listed below one by one and indicate how strongly

you feel each emotion when you think about the Corona Pandemic.
[Not at all 1 |---| 7 Extremly]
Upset
Alarmed
Nervous
Attentive
Anxious

C.12.2.2 Vaccination Action

6. **Have you already been infected with Corona?**
If yes, please indicate when you became symptom-free. If you are not sure, please provide an approximate date. *[Single Choice]*
Yes
No

7. **What is your current vaccination status?** *[Single Choice]*
[ ] I am fully vaccinated (received all necessary vaccinations).
[ ] Am partially vaccinated (received first of two vaccinations)
[ ] Have not been vaccinated yet, but have a vaccination appointment
[ ] Do not have a vaccination appointment yet, but have registered for a waiting list.
[ ] Have neither a vaccination appointment, nor have I been put on a waiting list

C.12.2.3 Treatment (only in the first survey in May/June 2021)

Particpants were randomly assigned to one of the conditions: Benefits treatment (T1), Debunk treatment (T2), or Control (C). The two treatment conditions are displayed each in turn below. In each treatment page participants were given arguments with short answers below. Furthermore, participants could click the "more information" button to receive detailed information and illustrations (upon request full information can be provided). Information given in each treatment were based on information pages of the German government, governmental organization, as well as non-governmental organization. However, sources were not named to not bias participants.

Treatment 1 Text: Benefits

Advantages for vaccinated people

For more than a year, Germany has been battling the Corona pandemic. Thanks to the Corona vaccine, a return to normalcy is finally on the horizon for vaccinated people. We have listed four of the biggest vaccination benefits for you here and would like to know whether these aspects played a role in your decision to be vaccinated or not.

1) The own protection In short: Vaccinations protect against infection and a severe progression.
- o One in ten people hospitalized for Corona require medical care
- o Up to 40% of those hospitalized for corona are between 20 and 54 years old.
- o One in five people hospitalized for corona dies
- o Vaccinations reduce the risk of contracting Corona by 70-95%.
- o Vaccinations reduce the risk of severe disease progression (hospital care) by 85%-100%.

2) The protection of others In short: Vaccinated people not only protect themselves, but others as well.
- o Vaccinated people have a significantly lower risk of passing on the virus
- o Vaccinated people protect all those who cannot be vaccinated for health reasons (e.g. the seriously ill, pregnant women, and children).
- o The fewer infected people there are, the more the burden on the health care system is reduced
- o Thus, every vaccinated person contributes to ending the pandemic

3) No contact restrictions and curfews for vaccinated people
In short: Vaccinated people are exempt from contact restrictions and curfews.
- o Vaccinated individuals are allowed to meet with any number of other vaccinated individuals
- o They are not considered contacts
- o There are no curfews for vaccinated people

4) No quarantine obligation for vaccinated persons
In short: Vaccinated people are free to travel and quarantine is not required.
- o More and more countries lift entry restrictions for vaccinated people
- o No quarantine obligation for return travelers
- o In addition, the quarantine obligation is waived after contact with infected persons

[> more information]

Treatment 2 Text: Debunking

Concerns about Corona vaccinations

Corona vaccinations have only recently been administered in Germany. Understandably, there are therefore many concerns among the population. We have listed four of the most common concerns here for you and would like to know whether or not the aspects mentioned play a role in your vaccination decision. Please read the information below and rate them based on their importance.

1) Is the vaccine safe despite rapid approval?
In short: Yes, thanks to prior knowledge, as well as financial and bureaucratic prioritization.
- o Corona viruses have been intensively researched since 2002
- o High financial support and simplification of bureaucracy
- o No idle time between study phases and many volunteers

2) Will a vaccine that is 70% effective protect me?
In short: Yes, it reduces the risk of infection (by 70%) and additionally the risk of a severe course. All vaccines approved in Germany reduce...
- o ...the risk of infection by 70-95%.
- o ...the risk of a severe course of the disease by 85-100%.

3) Are the side effects already well researched?
In short: Yes, a lot of data has already been collected due to the high application.
- o To detect very rare side effects, at least 100,000 applications are needed
- o In Germany alone, the Corona vaccine has already been used over 30,000,000 times
- o With the data collected worldwide, side effects that only occur in 1:1,000,000 people can be accurately identified.
- o This far exceeds the knowledge of side effects of other medical products
- o The risk of side effects is in the range of 0.0001%.

4) Will the vaccine stay in my body?
In short: No, vaccinations train the immune system by having it completely break down the vaccine. Through this process, the immune system learns how to cope with an actual infection.
- o Vaccines are administered only once or twice and are completely broken down within hours/days
- o Therefore, they cannot accumulate in the body
- o mRNA vaccines, for example, are completely degraded in less than 50 hours.
- o In this degradation process, side effects may occur. However, these have already been very well researched (see point 3).
- o According to the current state of knowledge, late side effects are not to be expected with the approved Corona vaccines.

C.12.2.4 5C-Scale

8. **What is your attitude towards the Corona vaccines?**
We would now like to know more about your attitude towards the vaccines. Please indicate your opinion for each of mRNA vaccines (BioNTech/Pfizer, Moderna) and vector vaccines (AstraZeneca, Johnson & Johnson).
[strongly disagree 1 |---| 7 strongly agree]

I have complete confidence in the safety of the vaccine.
... mRNA vaccines (BioNTech/Pfizer, Moderna)

... vector vaccines (AstraZeneca, Johnson & Johnson)

The vaccines are effective.
... mRNA vaccines (BioNTech/Pfizer, Moderna)
... vector vaccines (AstraZeneca, Johnson & Johnson)

As for Corona vaccines, I trust that government agencies always decide in the best interest of the public.
... mRNA vaccines (BioNTech/Pfizer, Moderna)
... vector vaccines (AstraZeneca, Johnson & Johnson)

9. **What is your attitude toward Corona vaccines in general?**
We would like to ask you now in more detail about Corona vaccines in general. Please indicate to what extent you agree with the following statements.

My immune system is so strong, it also protects me from getting Corona.

Corona is not so bad that I need to be vaccinated against it.

Everyday stress keeps me from getting vaccinated.

It is burdensome for me to get a vaccination.

My discomfort with doctor visits keeps me from getting vaccinated.

When I think about getting vaccinated, I weigh the benefits and risks to make the best decision possible.

For each vaccination, I consider very carefully whether it makes sense for me.

A full understanding of the vaccination issue is important to me before I get vaccinated.

If everyone is vaccinated, I don't need to get vaccinated too.

I get vaccinated because I can protect people with weak immune systems.

Vaccination is a collective action to prevent the spread of disease.

C.12.2.5 Prime Check

10. **How informed do you feel? [not informed at all 1 |---| 7 fully informed]**
… about the safety and effectiveness of Corona vaccines?
… about the benefits for fully vaccinated individuals?

C.12.2.6 Intention

11. **Would you get vaccinated against Corona if you had the opportunity next week?**
Please indicate your assessment for each of mRNA vaccines (BioNTech/Pfizer, Moderna) and vector vaccines (AstraZeneca, Johnson & Johnson).
[Definitely would not vaccinate 1 |---| 4 Undecided |---| 7 Definitely would vaccinate]
... mRNA vaccines (BioNTech/Pfizer, Moderna).
... vector vaccines (AstraZeneca, Johnson & Johnson)

12. **Reasons Behind**
a) If stated that either already took action and/or stated that they would be willing to get vaccinated:
How important were / are each of the following reasons to you in your decision to get vaccinated?
[Not important 1 |---| 7 Very important]
... To protect myself
... To protect people around me
... To do my part to overcome the crisis (herd immunity)
... To receive benefits (e.g., lifting of contact and travel restrictions)
... To be able to keep my job
... Other: ____
... Other: ____
... Other: ____

b) If stated that did not take action yet and are not willing to get vaccinated:
Why do you not want to be vaccinated? *[Not important 1 |---| 7 Very important]*
... Can't get vaccinated for medical reasons (e.g. pregnant, illness, etc.)
... Do not think it is necessary
... Think it is harmful
... Haven't found the time yet
... Don't know where to sign up...

… Other: ____
… Other: ____
… Other: ____

C.12.2.7 Anticipated Regret

13. **Please indicate to what extent you agree with the following statements.**
[Strongly disagree 1 |---| 7 Strongly agree]
I am afraid that I will regret having been vaccinated if I later have side effects from the vaccination.
I am afraid that I will regret not having been vaccinated if I later become seriously ill with corona.

C.12.2.8 Dogmatism

14. **To what extent do you agree with the following statements?** [Do not agree at all 1 |---| 7 Fully agree]
Any person who honestly and truly seeks the truth will eventually come to the same conclusions as I have.
The things I believe in are so completely true that I could never doubt them.
My opinions are correct and will stand the test of time.
My opinions and beliefs fit together perfectly and give a crystal clear "picture" of things.
There are no discoveries or facts that could make me change my mind about the most important things in life.
I am far from drawing definitive conclusions about life's central issues.
I am absolutely certain that my ideas about the basic issues of life are correct.
If persons are "open-minded" about the most important things in life, they are likely to draw the wrong conclusions.
Twenty years from now, some of my opinions about the important things in life will probably have changed.

C.12.2.9 Vaccination denied in past

15. **Have you refused vaccinations in the past or decided against vaccinating yourself or people for whom you are responsible (e.g. your child), contrary to medical advice?** [Single choice]
Yes
No

C.12.3 Emails sent between survey experiment and follow-up survey

Participants received emails between 10 August 2021 and 30 August 2021 weekly emails informing them corresponding to their treatment. The control group was randomly split into one group receiving facilitation emails (T3) and one pure control group (C). The other two treatments (T1: Benefits and T2: Debunk) received corresponding information. Some overlap of information exist between treatments: All treatments received information on where to get the vaccination.

The full text version of all email are available at:

https://github.com/IvoSteimanis/covid19_PLOS

D. Chapter 5: Supplementary material

The supplementary materials are organized as follows: In supplementary section D.1, we offer additional details on our two study samples. Representativeness checks are presented in section D.2. Additional findings are shown in D.3. Robustness checks regarding the confirmation bias and public opinion findings are presented in D.4 and D.5 respectively. In section D.6, barriers to transformation are discussed and in D.7 study materials are presented in for the interested reader.

D.1 Sample details

Table D.1 Extensive summary statistics of the farmer sample

	(1) Organic Farmers Mean/SD	(2) Conventional Farmers Mean/SD	(3) Pooled Mean/SD
Dependent variables			
Ignore organic information (=1)	0.13	0.18	0.15
	[0.33]	[0.39]	[0.36]
Ignore conventional information (=1)	0.29	0.10	0.18
	[0.46]	[0.30]	[0.39]
Main explanatory variable			
Ideology (0 Organic – 10 Conventional)	7.70	4.25	5.75
	[2.19]	[2.73]	[3.03]
Farmer mindset			
Profit orientation (0 – 10)	2.79	4.42	3.71
	[2.02]	[1.95]	[2.13]
Environmental awareness (0-10)	8.57	7.65	8.05
	[1.27]	[1.33]	[1.38]
Willingness to seek information (1-6)	4.76	4.74	4.75
	[1.15]	[1.04]	[1.09]
Sustainability over profit (1-6)	5.04	3.94	4.42
	[1.01]	[1.40]	[1.36]
Start-over as organic	0.81	0.37	0.56
	[0.39]	[0.49]	[0.50]
Farm characteristics			
Farming practice 0 Organic – 10 Conventional)	8.72	1.31	4.55
	[1.87]	[1.48]	[4.04]
Farm size (ln)	2.89	3.53	3.25
	[1.13]	[1.16]	[1.19]
Livestock (=1)	0.40	0.42	0.41
	[0.49]	[0.50]	[0.49]
Fulltime farmer (=1)	0.19	0.34	0.27
	[0.39]	[0.48]	[0.45]
Socioeconomics			
Age	49.06	52.02	50.73
	[10.41]	[9.51]	[9.98]
Female (=1)	0.10	0.10	0.10
	[0.31]	[0.30]	[0.30]
Household income			
<15,000 EUR – 26,000 EUR	0.13	0.06	0.09
	[0.33]	[0.25]	[0.29]
26,000 EUR – 32,000 EUR	0.15	0.08	0.11
	[0.36]	[0.27]	[0.31]
32,000 EUR – 38,000 EUR	0.10	0.11	0.11
	[0.31]	[0.32]	[0.31]
38,000 EUR – 45,000 EUR	0.10	0.11	0.11

	[0.31]	[0.32]	[0.31]
45,000 EUR – 50,000 EUR	0.17	0.18	0.17
	[0.38]	[0.39]	[0.38]
50,000 EUR – 55,000 EUR	0.08	0.06	0.07
	[0.28]	[0.25]	[0.26]
55,000 EUR – 60,000 EUR	0.08	0.08	0.08
	[0.28]	[0.27]	[0.28]
>60,000 EUR	0.19	0.31	0.25
	[0.39]	[0.46]	[0.44]
University degree (=1)	0.23	0.23	0.23
	[0.42]	[0.42]	[0.42]
Observations	48	62	110

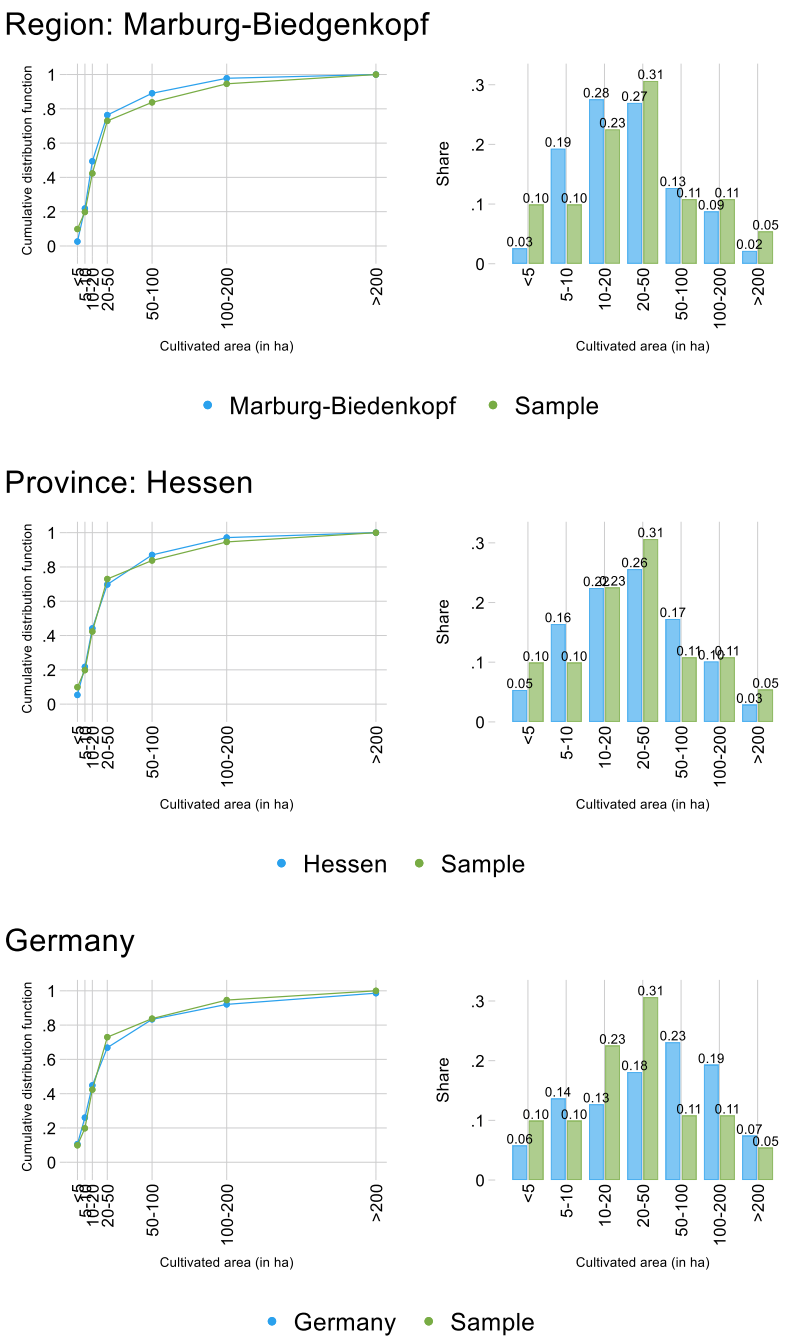
Table D.2 Summary statistics general population survey

	count	mean	sd	min	max
Age	821	49.16	13.11	18	81
Female (=1)	821	0.50	0.50	0	1
University degree (=1)	821	0.25	0.43	0	1
Monthly income (after tax)					
less than 250 €	821	0.01	0.10	0	1
250 € to under 500 €	821	0.02	0.13	0	1
500 € to under 1,000 €	821	0.08	0.27	0	1
1,000 € to under 1,500 €	821	0.12	0.32	0	1
1,500 € to under 2,000 €	821	0.11	0.32	0	1
2,000 € to under 2,500 €	821	0.14	0.35	0	1
2,500 € to under 3,000 €	821	0.13	0.33	0	1
3,000 € to under 3,500 €	821	0.10	0.30	0	1
3,500 € to under 4,000 €	821	0.10	0.31	0	1
4,000 € to under 4,500 €	821	0.05	0.22	0	1
4,500 € to under 5,000 €	821	0.05	0.22	0	1
5,000 € and above	821	0.09	0.28	0	1
Observations	821				

D.2 Representativeness

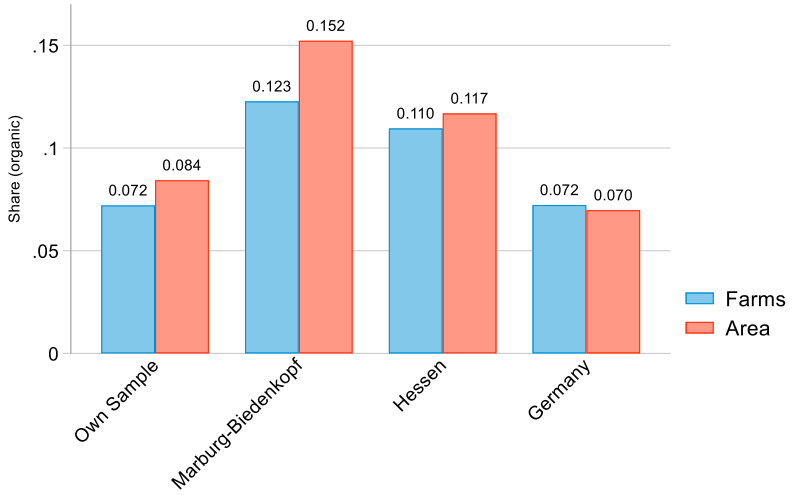
D.2.1 Farmer sample

Fig. D.1 Farm size



Note: Comparison of the share of organic farmers in Germany vs. our sample. In the official statistic, only farms having the German or European official certificate (Deutsches Bio Siegel / Europäisches Bio Siegel nach Verordnung EG NR 834/2007) are classified as such.

Fig. D.2 Share of organic farms and area cultivated using organic practices by region



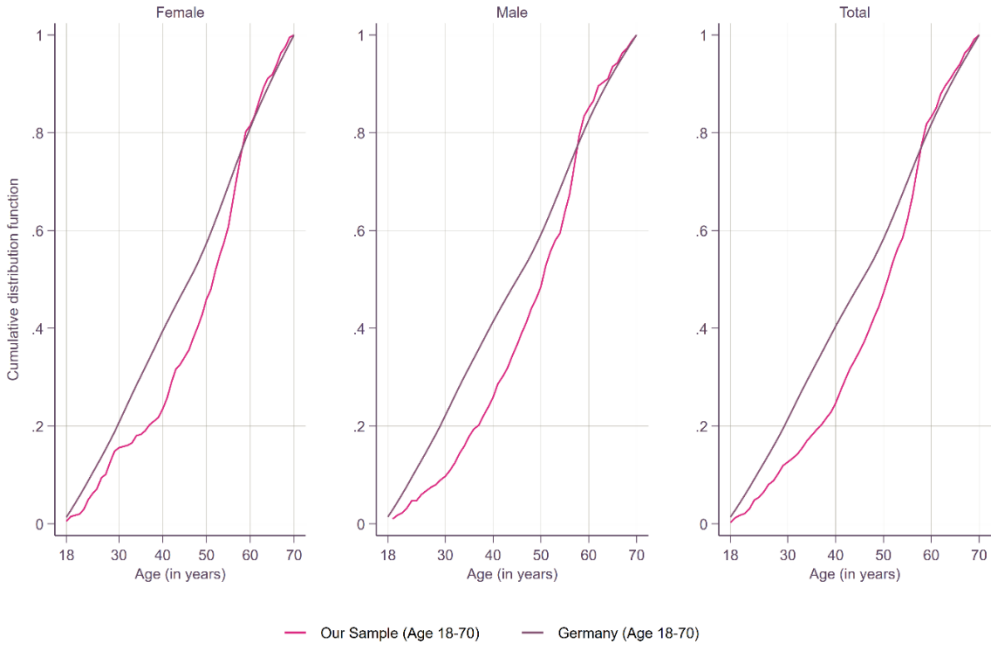
Note: Farms refer to the number of farms doing organic practice and area to the organically cultivated area in the corresponding region. Shares of the regions Marburg-Biedenkopf, Hesse, and Germany are taken from the official statistics. Total farms (sizes) are for our sample 5,485ha (110), Marburg Biedenkopf 49,223ha (1,198), Hesse 767,332ha (16,259) , and Germany 16,658,928ha (275,392). Classification as organic in the official statistic is based on official certificates (German and European Bio Certificate). For the classification of our sample, we follow the same classification rule.

D.2.2 General population sample

Participants were recruited from a general population panel in Germany by the survey company Respondi, which has mainly access to Germans between the age of 18-69 years. We aimed at a gender and age distribution similar to that of the German population within the accessible age bracket from 18-69. For targeting, we used the age distribution of the German population provided by the Statistische Bundesamt. We formed six age categories (18-25, 26-35, 36-45, 46-55, 55-69, 70, and above) for male and female participants respectively. Recruitment for a given age-gender combination was stopped once the target aimed for was reached.

In terms of gender, our sample is not statistically different from the age distribution in Germany in the age between 18 and 70. However, our final sample exceeds the German distribution in terms of people between 55 and 60 and we fall below the German distribution for those above 60.

Fig. D.3 Age distribution: sample vs. census



Note: Age distribution: sample vs. census. Comparison of cumulative age distribution in our sample to that of the German population. Where the inclination of our sample (blue line) is greater than that of the German population (orange line) age is oversampled.

Table D.3 Sample means vs. census data

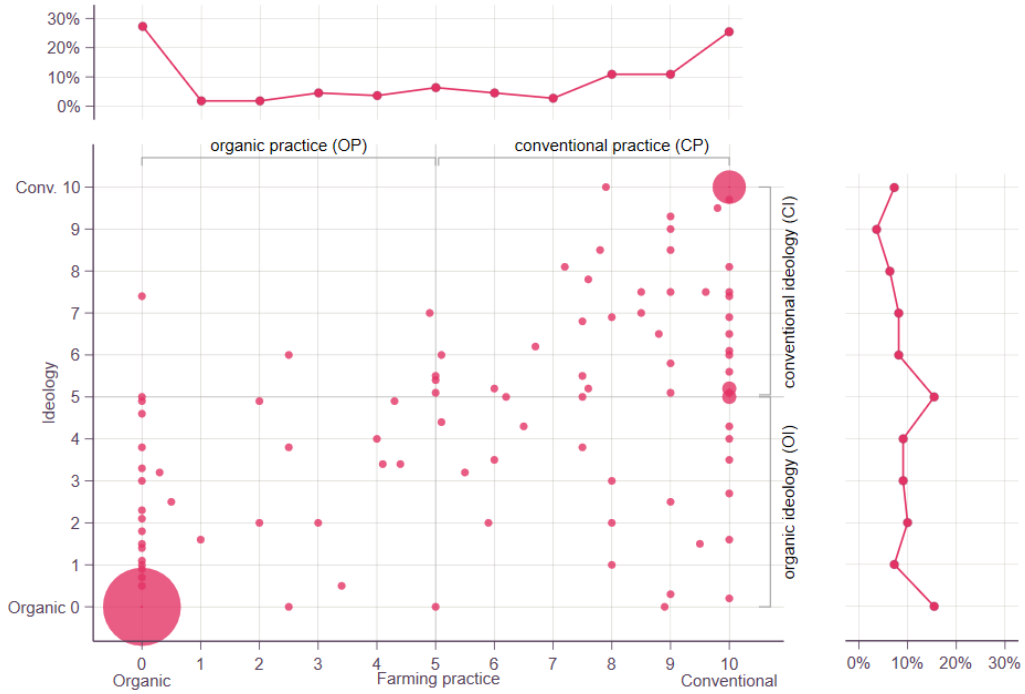
Variable	Study sample			Germany
	N	Mean	SD	Mean
Age (18-70)	821	49.16	13.11	45.030
Female (18-70)	821	0.50	0.50	0.496
Abitur	821	0.51	0.50	0.335
Household Size				
Single	821	0.17	0.38	0.406
2 Person	821	0.33	0.47	0.34
3 Person	821	0.28	0.45	0.121
4 Person	821	0.11	0.32	0.098
5 Person or more	821	0.11	0.31	0.035

Note: Summary of age, female, higher education (abitur), and household size of our sample and the German census. As our participants in our sample are mainly 18 to 70 years old we confine ourselves to a comparison of our sample with the German population for that age bracket in terms of age and female. As we did not find age-specific data fitting our dataset we compare education (Abitur) and Household house for the full age distribution.

D.3 Additional findings

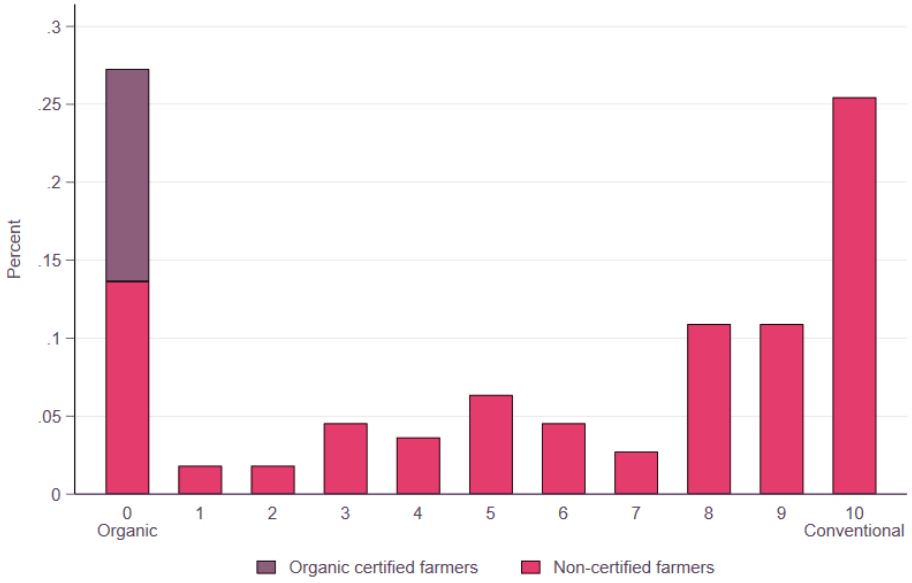
D.3.1 Farming practice and ideology

Fig. D.4 Distribution of farming practice and ideology



Note: Fig. D.4 shows the distribution of respondents' self-stated farming practices and farming ideology.

Fig. D.5 The farming practice of certified and non-certified farmers

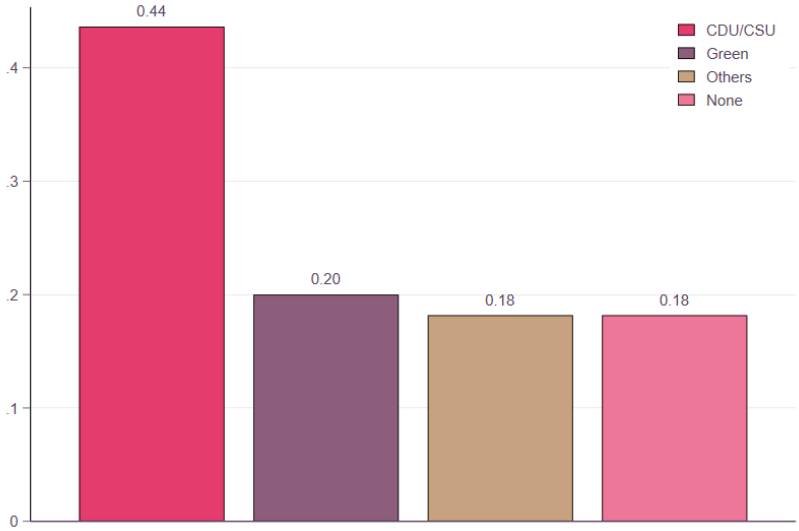


Note: Fig. D.5 plots self-stated farming practices for organic certified and non-certified farmers. Farming practice is plotted on the x-axis and ranges from 0 indicating that farmers fully adhere to organic farming practices and 10 indicating a completely conventional farming approach.

D.3.2 Political orientation of farmers

We asked respondents what political party represents the interests of farmers. We find that only 44% percent belief that the CDU/CSU, a traditionally strong representative of farmers' interests, still advocates on their behalf. Interestingly, 20% support the Green party, which strongly advocates for more environmental protection and stricter regulations. Finally, and most concerning, 18% of farmers in our sample reported that they fell no party represents their interests.

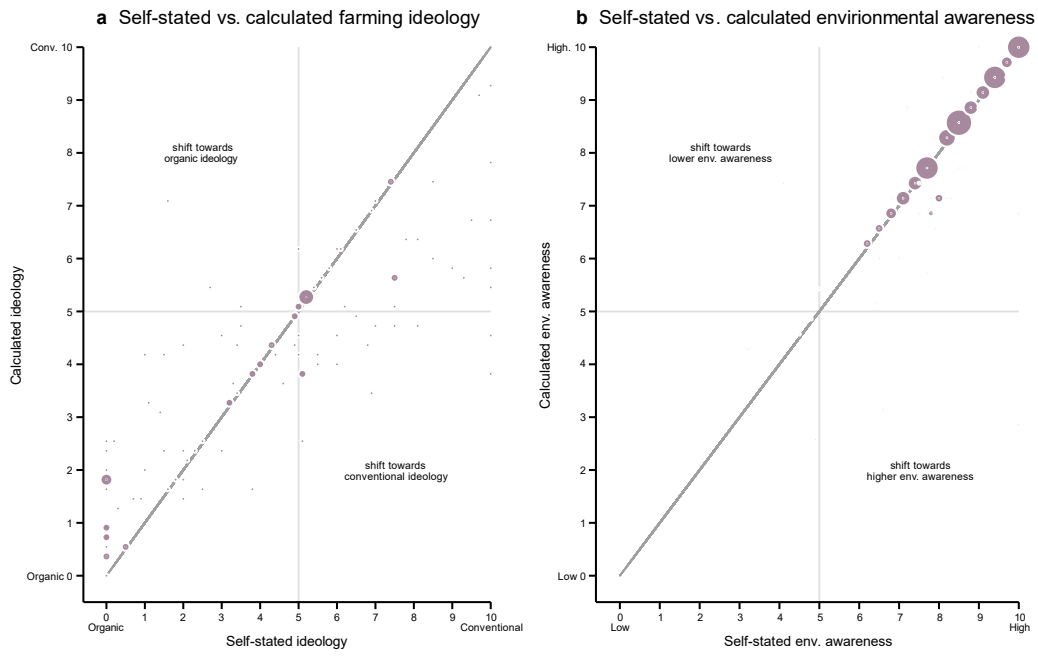
Fig. D.6 What party represents the interests of farmers?



Note: Fig. D.6 shows the percentages of farmers stating that CDU/CSU, Green party, other parties, or no party represents the interests of farmers.

D.3.3 Corrections made to calculated farming ideology and environmental awareness

Fig. D.7 Self-stated vs. calculated ideology and awareness

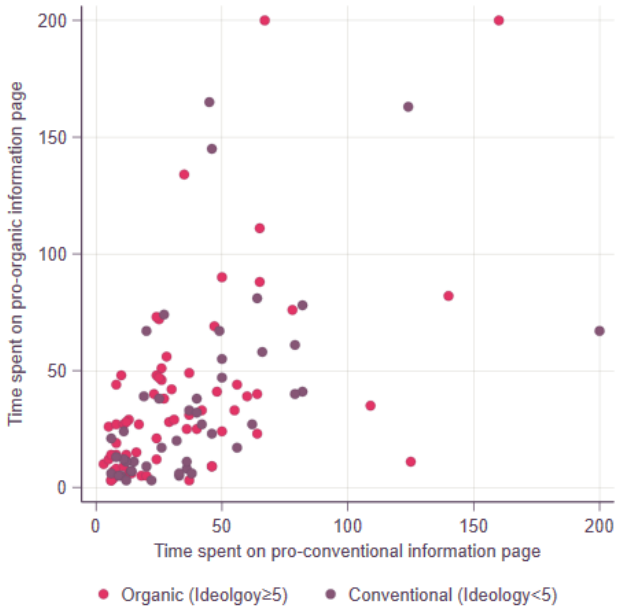


Note: Changes made to the calculated farming practice scale and farmers' environmental awareness.

D.3.4 Engagement with information pages

In the online survey, the time a participant spent on each page was recorded. Furthermore, we recorded whether participants clicked on the more detailed information provided on each information page. To compare the variables across ideologies we use a dummy taking the value 1 if the participants hold a conventional ideology (i.e., ideology < 5) and 0 otherwise. The time spent on each page by each participant is illustrated in Fig. D.8. Organic and conventional farmers do not differ in average time spent on either page (pro-organic page coefficient ß = 1.41 p = .855, 95%CI: -13.88 to 16.7; pro-conventional page coefficient ß = -5.72, p = .379, 95%CI: 18.57 to 7.12). Applying the Kolmogorov-Smirnov equality-of-distributions test suggests that the distribution of time spent on each page does not differ between organic and conventional ideology (pro-organic page D = .127, p = .788; pro-conventional page D = .178, p = .370).

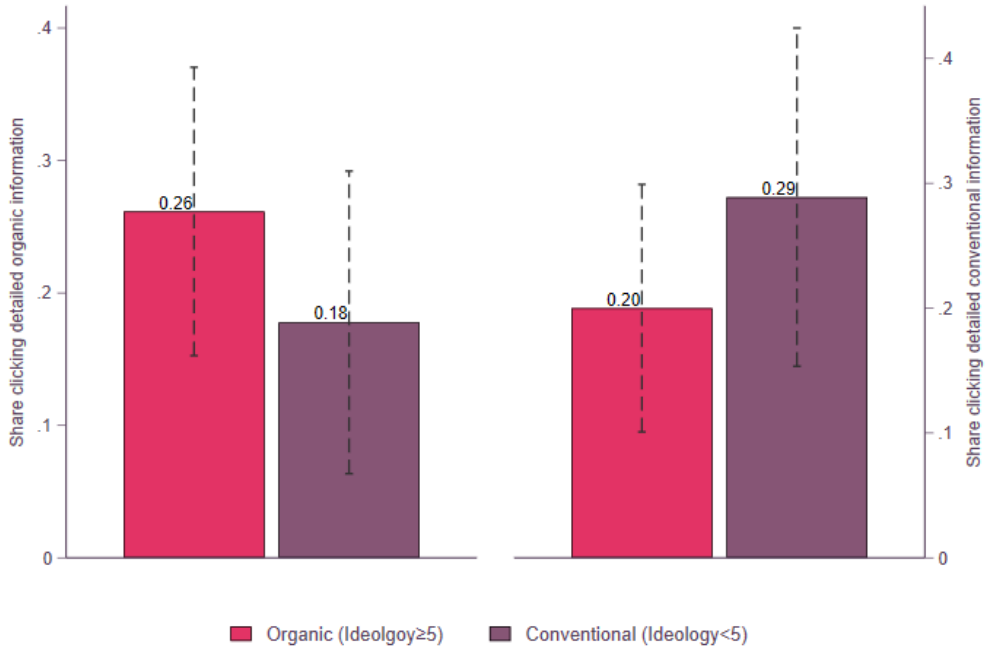
Fig. D.8 Time spent on each information page



Note: Time in seconds. Time spent on the information page highlighting benefits of organic agriculture on the y-axis, for benefits of conventional agriculture on the x-axis.

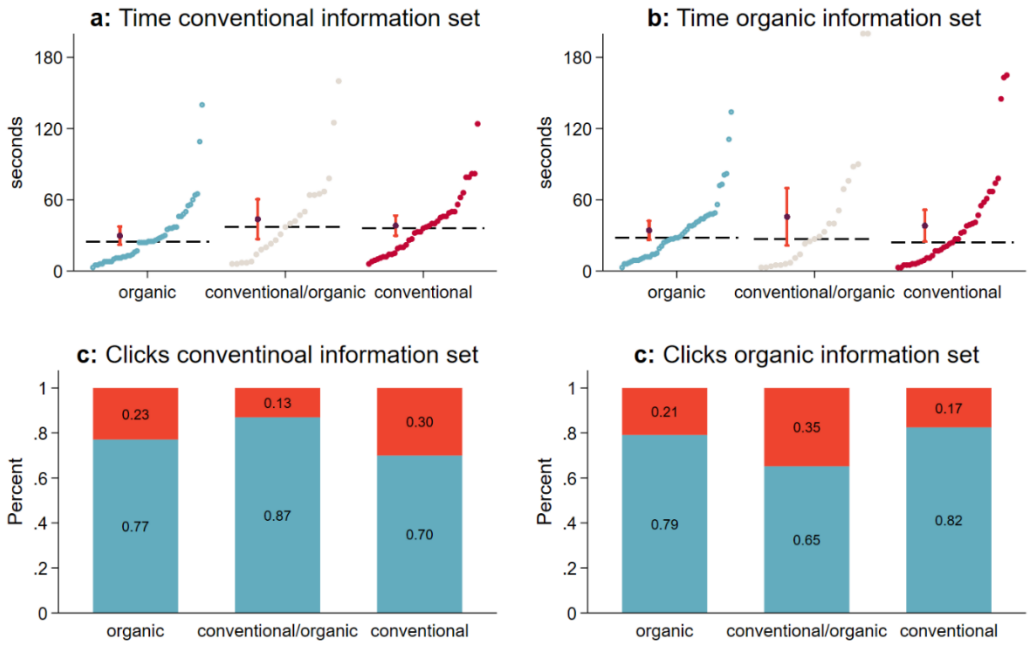
Furthermore, the share of participants clicking detailed information on either information set is illustrated in Fig. D.9. Again, the share of participants clicking at least one of the three detailed pieces of information provided between those with organic and conventional ideology does not differ to a statistically significant extent (pro-organic page coefficient ß = .084, p = .307, 95%CI: -.078 to .25; pro-conventional page coefficient ß = -.089, p = .285, 95%CI: -.25 to .075).

Fig. D.9 Share clicking detailed information



Note: Shares by ideology-dummy and 95% confidence intervals. Plotted are the shares of participants who clicked at least one of the three detailed information provided on each information page.

Fig. D.10 Engagement with information sets across farmer types



D.4 Robustness checks of confirmation bias

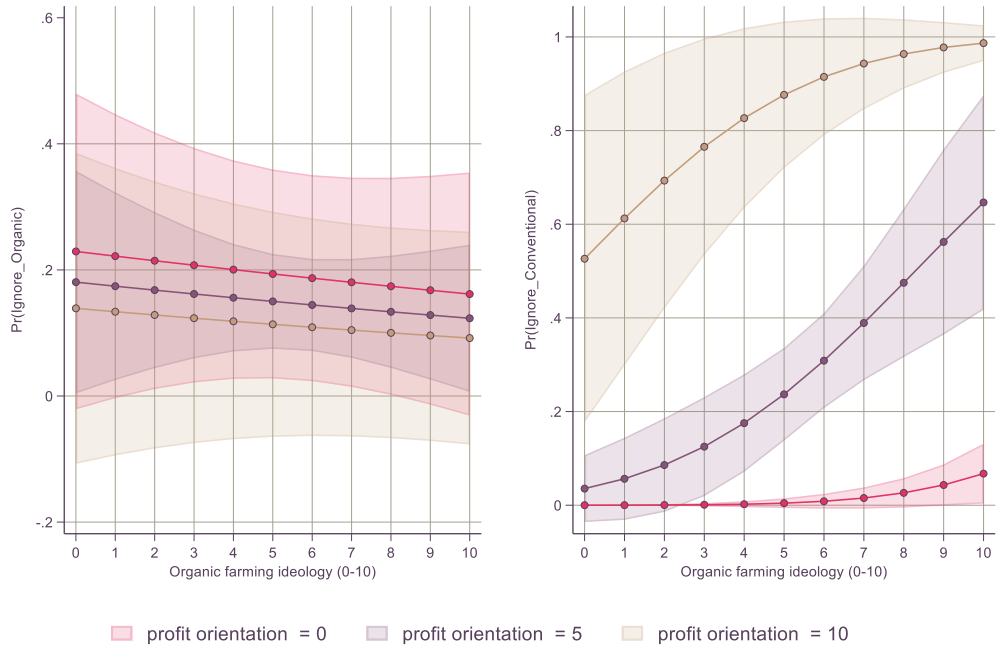
Table D.4 shows the stepwise construction of the main regression to illustrate the effects of the various determinants on explaining the variance of the dependent variable.

Table D.4 Extensive regression table

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ignore Organic				Ignore Conventional			
Ideology (0-10)	-0.01	-0.01	-0.01	-0.01	0.03**	0.05***	0.05***	0.05***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Farmer mindset								
Profit orientation		-0.00	-0.00	-0.01		0.06***	0.07***	0.09***
		(0.02)	(0.02)	(0.02)		(0.02)	(0.02)	(0.02)
Env. awareness		-0.00	0.00	0.01		0.04	0.04	0.03
		(0.03)	(0.03)	(0.03)		(0.03)	(0.03)	(0.03)
Seek information		-0.01	-0.01	-0.01		0.03	0.03	0.02
		(0.03)	(0.03)	(0.03)		(0.04)	(0.04)	(0.04)
Env. protection		-0.00	0.00	-0.01		0.00	0.00	0.04
		(0.04)	(0.04)	(0.04)		(0.04)	(0.04)	(0.03)
Farm characteristics								
Farm size (ln)			0.01	0.01			-0.05	-0.06**
			(0.03)	(0.03)			(0.03)	(0.03)
Livestock (=1)			0.07	0.04			0.07	0.11
			(0.07)	(0.07)			(0.08)	(0.07)
Fulltime farmer			-0.04	-0.03			0.11	0.02
(=1)			(0.08)	(0.07)			(0.08)	(0.06)
Farmer characteristics								
Age				-0.00				0.01**
				(0.00)				(0.00)
Female (=1)				0.18*				0.04
				(0.10)				(0.08)
Income				0.04***				-0.04***
				(0.01)				(0.01)
Higher education				-0.07				0.13**
(=1)				(0.09)				(0.06)
Observations	110	110	110	110	110	110	110	110
Pseudo R-squared	0.00	0.01	0.02	0.10	0.08	0.18	0.21	0.33
Mindset		1.00	0.67	0.79		0.02	0.00	0.17
Farm characteristics			1.00	0.99			0.33	0.00
Socio-economics				0.03				0.00

Note: The binary dependent variable indicates whether respondents stated that the information that highlights the sustainable benefits of organic farming (column 1-4) or conventional farming (column 5-8) should be ignored. Ideology is a self-stated assessment taking the value 0 on the extreme conventional and 10 at the extreme organic. Profit orientation is a self-stated assessment taking the value 0 on the extreme impact-oriented and 10 at the extreme profit-oriented. Environmental awareness is a self-stated assessment measuring the willingness to conserve the environment in private taking the value 0 on the extreme low willingness and 10 at the extreme high willingness. Willingness to seek information is an index based on three survey items measuring farmers' willingness to seek information regarding agricultural methods preserving the environment. Environmental protection is a survey item asking farmers on their willingness to invest in environmentally friendly technologies even if this means forgoing profits. Farm size measured in hectare area (logarithm). Income in categories. Higher education is 1 if the participants hold a certificate of higher education (allgemeine or fachgebundene Hochschulreife). Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Fig. D.11 Predictive margins of ideology given profit orientation



Notes: The figure shows the prediction margins with 95% confidence intervals of ideology at low, medium, and high profit orientation. The confidence intervals are indicated by the shaded area for each profit orientation group.

D.4.1 Defining farming ideology

In our main analysis, the ideology variable ranges from 0, signifying strong support for conventional agriculture, to 10, strong support for organic farming. Alternatively, we can "break" the scale into two in the middle (i.e., at 5) and calculate for each the deviation from the center. In this way, being at the conventional ideology extreme will yield the same numerical value as being on the organic extreme (i.e., 5). Moving from either of these extreme points one point will decrease the strengths of the ideology by one point. This scale may be therefore interpreted as the distance the participant under consideration has from a neutral opinion. The higher the value, the stronger the opinion towards one or the other direction. The two variables constructed from ideology are

$$Conventional\ ideology = \begin{cases} |ideology - 5|, & ideology < 5 \\ 0, & ideology \geq 5 \end{cases} \quad (1)$$

and

$$Organic\ ideology = \begin{cases} |ideology - 5|, & ideology \geq 5 \\ 0, & ideology < 5 \end{cases} \quad (2)$$

The variables take the value 0 if the participant holds the opposed ideology. Conventional ideology takes the value 0 if the participant has an organic ideology (i.e., ideology greater or equal to five) and vice versa. We count those who reported an ideology of 5 towards those with organic ideology (n = 5).

Table D.5 Robustness test using mono polar variables for ideology

VARIABLES	(1) Ignore organic (=1)	(2) Ignore conventional (=1)
Conventional ideology (0-5)	0.04	0.00
	(0.03)	(0.03)
Organic ideology (0-5)	-0.00	0.08***
	(0.02)	(0.02)
Farmer mindset		
Profit orientation	-0.01	0.07***
	(0.02)	(0.02)
Env. awareness	-0.00	-0.01
	(0.03)	(0.03)
Seek information	-0.02	0.02
	(0.03)	(0.04)
Env. protection	0.00	0.02
	(0.04)	(0.05)
Farm characteristics		
Farm size (ln)	-0.01	-0.03
	(0.04)	(0.04)
Livestock (=1)	0.08	0.02
	(0.07)	(0.09)
Fulltime farmer (=1)	-0.07	-0.03
	(0.09)	(0.10)
Farmer characteristics		
Age	-0.01	0.01**
	(0.00)	(0.00)
Female (=1)	0.20*	0.04
	(0.11)	(0.12)
Income	0.04**	-0.01
	(0.02)	(0.02)
Higher education (=1)	-0.10	0.06
	(0.09)	(0.09)
Observations	110	110
Pseudo R-squared	0.12	0.16
Mindset	0.97	0.04
Farm characteristics	0.69	0.76
Socio-economics	0.02	0.18

Notes: Dependent variables measuring whether participants suggested to ignore information that highlight benefits of conventional or organic agriculture respectively. Conventional and organic ideology range from 0 to 5 taking the value 0 if the person has an organic or conventional ideology respectively. Profit orientation is a self-stated assessment taking the value 0 on the extreme impact oriented and 10 at the extreme profit oriented. Environmental awareness is a self-stated assessment measuring the willingness to conserve the environment in private taking the value 0 on the extreme low willingness and 10 at the extreme high willingness. Willingness to seek information is an index based on three survey items measuring farmers willingness to seek information regarding agricultural methods preserving the environment. Environmental protection is a survey item asking farmers on their willingness to invest in environmentally friendly technologies even if this means forgoing profits. Farm size measured in hectare area (logarithm). Income in categories. Higher education is 1 if the participant holds a certificate of higher education (allgemeine or fachgebundene Hochschulreife). Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

D.4.2 Using the calculated score for ideology instead of self-assessment

Farming ideology was measured in two steps: First, we asked farmers how much they agree or disagree with eleven polarizing statements, e.g., ‘Conventional agriculture is better suited to ensure food security’ and ‘Grazing is indispensable for species-appropriate cattle farming’ (α = .820). Based on their answers we ranked them on a scale from 0 fully ‘organic ideology’ to 10 fully ‘conventional ideology’. Respondents were then asked to adjust the resulting score in case they felt misrepresented (see Fig. D.5A for the

adjustments made). In the main analysis, we use the adjusted scores, that is respondents' self-stated ideology score. In Table D.6, we test whether the results remain if we use the calculated ideology score instead.

Table D.6 Robustness check: Main results using calculated farming ideology

VARIABLES	(1) Ignore organic (=1)	(2) Ignore conventional (=1)
Calculated ideology (0-10)	-0.01	-0.05*
	(0.02)	(0.03)
Farmer mindset		
Profit orientation (0-10)	-0.00	0.07***
	(0.02)	(0.02)
Env. awareness (0-10)	-0.00	0.02
	(0.03)	(0.04)
Seek information (1-6)	-0.00	0.01
	(0.03)	(0.04)
Env. protection (1-6)	-0.03	0.03
	(0.04)	(0.04)
Farm characteristics		
Farm size (ln)	0.02	-0.06*
	(0.03)	(0.03)
Livestock (=1)	0.05	0.11
	(0.07)	(0.08)
Fulltime farmer (=1)	-0.02	0.01
	(0.07)	(0.07)
Farmer characteristics		
Age	-0.00	0.01**
	(0.00)	(0.00)
Female (=1)	0.17*	0.03
	(0.10)	(0.09)
Income	0.04***	-0.03**
	(0.01)	(0.01)
Higher education (=1)	-0.08	0.14**
	(0.09)	(0.06)
Observations	110	110
Pseudo R-squared	0.11	0.26
Mindset	0.96	0.00
Farm characteristics	0.76	0.33
Socio-economics	0.03	0.03

Notes: The binary dependent variable indicates whether respondents stated that the information that highlights the sustainable benefits of organic farming (column 1) or conventional farming (column 2) should be ignored. Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

D.4.3 Comparing only ignoring with non-ignoring respondents

In our main analysis, the binary dependent variables ignore organic and ignore conventinal take the value 1 if ignore is greater than 6 or smaller than 6 respectively and 0 otherwise. In other words, if the person deviated from "do not ignore any information" towards ignore organic or conventional the corresponding variable takes the value 1. This implies, that the variable takes the value 0 if the person suggests to ignore neither information or to ignore the opposing information. Hence, in our main regression, we estimate whether the ideology in either direction affects the likelihood to suggest to ignore the information set highlighting the benefits of organic agriculture compared to either suggesting to not ignore any information or to ignore the information set highlighting the benefits of conventional

agriculture. Alternatively, we could estimate the effect of ideology on suggesting to ignore the information on organic agriculture compared to not ignoring any of the information only. To do so we split our sample into (i) those reporting to ignore none of the information or to ignore the information highlighting the benefits of organic agriculture, and (ii) those reporting to ignore none of the information or to ignore the information highlighting the benefits of conventional agriculture. Thereby, each subsample is reduced by the number of participants ignoring the opposed information set. The results are reported in Table D.7. Using the two subsamples does not alter the results.

Table D.7 Robustness test comparing biased to non-biased only

VARIABLES	(1) Ignore organic (=1)	(2) Ignore conventional (=1)
Ideology (0-10)	-0.00	0.06***
	(0.02)	(0.02)
Farmer mindset		
Profit orientation (0-10)	0.01	0.10***
	(0.03)	(0.03)
Env. awareness (0-10)	-0.00	-0.03
	(0.04)	(0.04)
Seek information (1-6)	-0.01	0.04
	(0.05)	(0.05)
Env. protection (1-6)	-0.02	0.02
	(0.06)	(0.06)
Farm characteristics		
Farm size (ln)	-0.04	-0.10**
	(0.06)	(0.05)
Livestock (=1)	0.07	0.07
	(0.10)	(0.11)
Fulltime farmer (=1)	-0.01	0.00
	(0.11)	(0.11)
Farmer characteristics		
Age	-0.01	0.02***
	(0.00)	(0.01)
Female (=1)	0.24	0.19
	(0.15)	(0.16)
Income	0.05***	-0.00
	(0.02)	(0.02)
Higher education (=1)	-0.12	0.06
	(0.13)	(0.11)
Observations	80	90
Pseudo R-squared	0.12	0.17
Mindset	0.93	0.22
Farm characteristics	0.87	0.01
Socio-economics	0.01	0.04

Notes: Dependent variables measuring whether participants suggested to ignore information that highlight benefits of conventional or organic agriculture respectively. Ideology are self-stated assessments taking the value 0 on the extreme conventional and 10 at the extreme organic. Profit orientation is a self-stated assessment taking the value 0 on the extreme impact oriented and 10 at the extreme profit oriented. Environmental awareness is a self-stated assessment measuring the willingness to conserve the environment in private taking the value 0 on the extreme low willingness and 10 at the extreme high willingness. Willingness to seek information is an index based on three survey items measuring farmers willingness to seek information regarding agricultural methods preserving the environment. Environmental protection is a survey item asking farmers on their willingness to invest in environmentally friendly technologies even if this means forgoing profits. Farm size measured in hectare area (logarithm). Income in categories. Higher education is 1 if the participants hold a certificate of higher education (allgemeine or fachgebundene Hochschulreife). Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

D.4.4 Excluding potential protest answers

A remarkable number of participants made use of the opportunity to provide feedback after completing the questionnaire (n = 36). Some of these comments can be classified as angry or hostile (n = 8). It seems that participants offering those comments felt pushed into a corner by the questions asked. The comments suggest that participants gained the feeling that the questionnaire was set up in contra of conventional farmers. All angry comments came from participants that stated to be conventionally oriented. We tried to formulate the questionnaire as balanced as possible. Beyond, others provided more positive comments. However, whether we have achieved our goal of avoiding biasing the questionnaire in any direction is for the reader to judge. We ran an estimation without the observations classified as enraged as we assumed these participants to fill the questionnaire in a protesting manner. The results of the regression are reported in Table D.8. Excluding participants potentially providing protest answers does not alter the results.

Table D.8 Robustness test excluding potential protest answers

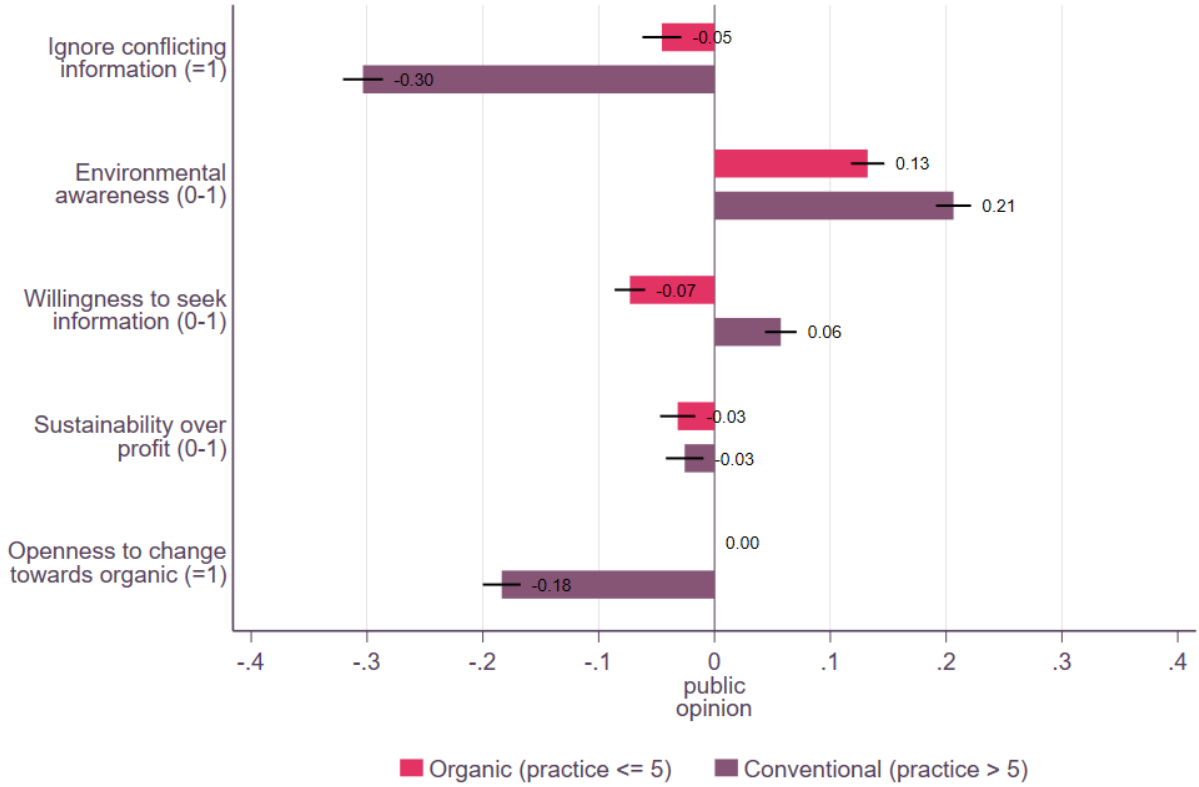
VARIABLES	(1) Ignore organic (=1)	(2) Ignore conventional (=1)
Ideology (0-10)	-0.01	0.04**
	(0.02)	(0.02)
Farmer mindset		
Profit orientation (0-10)	-0.01	0.07***
	(0.02)	(0.02)
Env. awareness (0-10)	0.00	0.01
	(0.03)	(0.03)
Seek information (1-6)	-0.01	0.03
	(0.04)	(0.04)
Env. protection (1-6)	-0.02	0.04
	(0.04)	(0.04)
Farm characteristics		
Farm size (ln)	0.01	-0.07**
	(0.03)	(0.03)
Livestock (=1)	0.03	0.11
	(0.07)	(0.08)
Fulltime farmer (=1)	-0.03	-0.00
	(0.07)	(0.06)
Farmer characteristics		
Age	-0.00	0.01*
	(0.00)	(0.00)
Female (=1)	0.21*	0.05
	(0.11)	(0.09)
Income	0.04***	-0.03**
	(0.02)	(0.01)
Higher education (=1)	-0.08	0.14**
	(0.09)	(0.06)
Observations	102	102
Pseudo R-squared	0.12	0.31
Mindset	0.97	0.09
Farm characteristics	0.87	0.00
Socio-economics	0.01	0.01

Notes: Dependent variables measuring whether participants suggested to ignore information that highlight benefits of conventional or organic agriculture respectively. Ideology are self-stated assessments taking the value 0 on the extreme conventional and 10 at the extreme organic. Profit orientation is a self-stated assessment taking the value 0 on the extreme impact oriented and 10 at the extreme profit oriented. Environmental awareness is a self-stated assessment measuring the willingness to conserve the environment

in private taking the value 0 on the extreme low willingness and 10 at the extreme high willingness. Willingness to seek information is an index based on three survey items measuring farmers willingness to seek information regarding agricultural methods preserving the environment. Environmental protection is a survey item asking farmers on their willingness to invest in environmentally friendly technologies even if this means forgoing profits. Farm size measured in hectare area (logarithm). Income in categories. Higher education is 1 if the participants hold a certificate of higher education (allgemeine or fachgebundene Hochschulreife). Non-linear probability model using probit link function and computing average marginal effects with robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

D.5 Robustness checks and additional results: public opinion

Fig. D.12 Deviation of farmers' responses from public opinion



D.6 Barriers to transformation

D.6.1 Differences between farmer types

In the previous step, we compare similarities between "open" farmers (having conventional practices but rather organic ideological beliefs) and pure organic and conventional farmers to learn about the factors that attract them towards organic agriculture and reasons that may hold them back from actually doing so. This inference is based on the assumption, that similarities to organic farmers are the sources of attraction towards organic agriculture, while similarities to conventional farmers pose reasons for them not to change towards organic agriculture.

Table D.9 Barriers to transformation

VARIABLES	(1) Org-Conv (n=23) Mean/[SD]	(2) Org-Org (n=42) Mean/[SD]	(3) Conv-Conv (n=40) Mean/[SD]	(1)-(2) t-test Diff/[P]	(1)-(3) t-test Diff/[P]
Time-dependent lock-in					
Age of farmer (Years)	52.52	49.24	51.45	3.28	1.07
	[8.08]	[9.40]	[10.36]	[0.163]	[0.671]
Age of farm (Years)	151.30	114.48	201.55	36.83	-50.25
	[85.72]	[118.49]	[149.20]	[0.194]	[0.145]
Educational lock-in					
University Degree	0.26	0.24	0.20	0.02	0.06
	[0.45]	[0.43]	[0.41]	[0.842]	[0.583]
Agric. Education (=1)	0.48	0.36	0.60	0.12	-0.12
	[0.51]	[0.48]	[0.50]	[0.348]	[0.357]
Ideological lock-in (PCA)					
Motivated reasoning	0.26	0.38	0.23	-0.12	0.04
(ignore other opinion)	[0.45]	[0.49]	[0.42]	[0.336]	[0.752]
Willingness to invest	0.33	0.59	-0.53	-0.26	**0.86***
in eco-friendly technology	[1.83]	[1.81]	[1.76]	[0.581]	[0.072]
General envrionmental	0.41	0.64	-0.76	-0.22	**1.17*****
awareness	[1.48]	[1.55]	[1.53]	[0.573]	[0.004]
Profit-seeking	0.50	-0.78	0.63	**1.27*****	-0.14
	[1.86]	[1.82]	[1.64]	[0.009]	[0.764]
Farm characteristics					
Farm size (PCA)	-0.54	-0.40	0.84	-0.14	**-1.38****
	[1.06]	[1.90]	[2.48]	[0.740]	[0.014]
Income generated by	11.38	8.76	14.74	2.62	-3.36
agriculture (T EURO)	[12.23]	[12.70]	[12.71]	[0.424]	[0.310]
F-test of joint significance (F-stat)	1.64	1.92*			
F-test, number of observations	65	63			

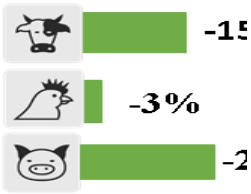
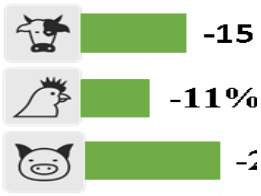
Notes: Standard deviation in square brackets for columns (1)-(3); p-values for columns (4) and (5). *** p<0.01, ** p<0.05, * p<0.1. Columns (1) to (3) display the means for those with organic ideology and conventional practice, organic ideology, and organic farm practice, and conventional ideology and conventional practice respectively. The two rightmost columns show the t-test for differences between those with organic ideology and conventional practice and those with organic ideology and organic practice (4), and with conventional ideology and conventional practice (5)

D.6.2 Back-on-the-envelop calculations

In total, the 110 farmers in our sample cultivate 5.28k ha. Of these, 4.46k ha are farmed by farmers who are not certified organic. The 30% of farmers who reported that they mainly used organic farming methods, although not certified organic, cultivated a total area of 0.83k ha, or 19% of the total conventionally farmed area. 51% (48 out of 95) of all conventional farmers stated that they would prefer to start an organic farm if they could start over again. In total, they cultivate 1.73k ha or 39% of all conventionally farmed land. Thus, if all conventional farmers who stated that they would change to organic farming actually would change, the overall share of organic farming would increase from 14% to 57% in our sample. This would imply an increase of almost 420%.

In Germany, there are a total of 16,659k ha cultivated by 255,491 farms. Assuming that the distribution of our sample is the same as that of German farmers, we apply our proportions to the totals, resulting in 14,387k ha and 2,272k ha of conventionally and organically farmed land, respectively. Thus, if all conventional farmers could freely switch to organic farming, the size of organically cultivated land would increase from 2,272k to 9,542k ha.

D.7 Study materials

Information 1: Sustainable benefits of conventional agriculture	Information 2: Sustainable benefits of organic agriculture
<u>Saving greenhouse gases through conventional agriculture</u> (compared to organic farming) Some studies on farm animal husbandry suggest that conventional agriculture produces lower levels of greenhouse gases than organic agriculture. These savings in conventional farming compared to organic farming are shown in the following graph:  Reasons for the lower greenhouse gas emissions in conventional agriculture compared to organic agriculture are: 1) Higher yields Due to higher efficiency, less land is used in conventional agriculture. 2) Low fuel consumption The use of appropriate means reduces fuel consumption in conventional farming compared to organic farming. 3) Faster fattening Faster fattening and better feed conversion efficiency lead to lower energy consumption and ultimately lower greenhouse gas emissions. *Sources: Beef - Williams et al. (2006); Pork - Alig et al. (2012); Poultry - Leinonen et al. (2012)*	**<u>Saving greenhouse gases through organic agriculture</u>** (compared to conventional agriculture) Some studies on livestock farming suggest that organic farming produces lower levels of greenhouse gases than conventional farming. These savings in organic farming compared to conventional farming are shown in the following graph:  Reasons for the lower greenhouse gas emissions in organic agriculture compared to conventional agriculture are: 1) Gentle soil cultivation Due to the higher humus content in the soil, more CO2 can be bound. 2) Avoiding the use of artificial fertilizers and pesticides By dispensing with mineral fertilizers and synthetic pesticides, organic farming emits fewer greenhouse gases. 3) Feeding, livestock stocking and types of housing with slurry production A feeding rich in crude fibre, a low livestock population and housing forms without slurry production reduce the emission of greenhouse gases. *Sources: Sources: Beef - Casey and Holden(2006); Pork - Williams et al. (2006); Poultry - Boggia et al. (2010*

Information Assessment: Comparison of studies											
	Given the information about organic and conventional agriculture, which of the two pieces of information do you think should be ***<u>ignored</u>*** in the current discussion about climate and environmental protection in Germany? Show your opinion using the scale below. Five points on the left means that information showing that organic farming is more climate friendly should be completely ignored. Five points on the right means that information showing that conventional agriculture is more climate friendly should be completely ignored. The middle (0 points) means that neither information should be ignored.										
	Ignore pro-organic information										*Ignore pro-conventional information*
	5	4	3	2	1	0	1	2	3	4	5