PNAS RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES OPEN ACCESS

The private solution trap in collective action problems across 34 nations

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Edited by Robert Böhm, Universitat Wien, Vienna, Austria; received March 31, 2025; accepted February 10, 2026 by Editorial Board Member Margaret Levi

Collective action problems emerge when individual incentives and group interests are misaligned, as in the case of climate change. Individuals involved in these problems are generally considered to have two options: contribute toward public solutions such as global warming mitigation or free ride. However, many collective action problems today involve a third option of investing in a "private solution" such as local adaptation. The availability of this third option can lead to a private solution trap whereby private solutions are adopted, collectively optimal public solutions are not provided, and existing inequalities are exacerbated. We investigated the private solution trap with a collective action game featuring private and public solutions, wealth inequality determined by luck or merit, and participants from 34 countries. We found that the joint existence of private solutions and wealth inequality had a consistent effect across countries: Participants given a higher endowment adopted private solutions almost twice as often as those given a lower endowment, regardless of whether it was determined by luck or merit, and contributed proportionally less toward public solutions. Wealth inequality increased in every country and those given lower endowments were often left unprotected as public solutions were not provided. Across countries, cultural values of hierarchy and harmony were associated with preferences for private and public solutions, respectively. We also identified two universal pathways toward public solution provision: early contributions and conditional cooperation. Our findings highlight the ubiquity of the private solution trap, its cultural underpinnings, and its potential consequences for global collective action problems.

human cooperation | social dilemma | climate change | private solutions | cross-cultural study

Significance

One of the main goals of international climate change negotiations is to distribute the economic burden of limiting global warming. A central challenge is that some countries are wealthier than others and may therefore be better able to invest in local adaptation (a "private solution") as an alternative to global mitigation (a "public solution"). We studied this challenge with a collective action problem that participants—who were given high or low endowments—could solve privately or publicly. Across 34 countries, we found that wealth inequality increased as participants with high endowments consistently adopted private solutions. Our findings highlight the potential challenges of what we call the private solution trap.

Many of our most pressing collective action problems today are global in scope. Combating pandemics, ensuring global security, and addressing climate change all require international collaboration. Human beings have a remarkable track record of solving shared problems collectively (1–3). At a national level, we have developed public health systems to protect us from disease, school systems to educate our young, and transport systems to help us move around. Shifting to the global level makes solving such problems more challenging by adding the complexity of greater cultural and socioeconomic variation (4–6).

Public health, school, and transport systems are all examples of "nonexcludable" public goods that can benefit everyone. This feature leaves public goods vulnerable to the *free-rider problem* as it enables beneficiaries to contribute nothing to their provision without sacrificing access (7–13). When investigating the free-rider problem, researchers typically consider the tension between contributing to public goods vs. free-riding. There is often a third option, however, which has received less attention: investing in an excludable "private solution" (14–16). Only when individuals and nations forego the temptation to free-ride and contribute to public rather than private solutions is a public solution likely

This article is a PNAS Direct Submission. R.B. is a guest editor invited by the Editorial Board.

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This article contains supporting information online at https://www.pnas.org/lookup/suppl/doi:10.1073/pnas.2504632123/-/DCSupplemental.

Published March 20, 2026.

to succeed. We call this second vulnerability the *private solution trap*.[*] Here we assess its causes and consequences in an experimental collective action problem conducted in 34 countries.

Private solutions abound in the modern world. In the domains of healthcare, education, and transport, many individuals adopt private solutions in the form of private health insurance, private schools, and private cars rather than use the public alternatives. Likewise, gated communities and private security agencies offer individuals an excludable approach to avoiding crime. At an international level, excessively stockpiling vaccines during the COVID-19 pandemic similarly represented a private solution to the collective action problem of global inoculation (17, 18). It is in the context of climate change, however, that private solutions are perhaps most relevant. For individuals, private solutions include migrating to avoid rising temperatures and extreme weather events (19, 20) and, in response to wildfires in the United States in 2025, recruiting private firefighters (21) and purchasing private fire hydrants (22). For governments, they include local adaptation measures, from building flood protection and water management systems (23) to rerouting rivers (24) and seeding clouds for enhanced precipitation (25),[†] as alternatives to the public solution of global warming abatement (26, 27).

These private solutions represent a trap because a) they tend to be less socially efficient than public solutions and undermine support for the latter; and b) they are more affordable for some than others and exacerbate existing inequalities. In education, for example, the share of private education spending within a country is positively related to its level of income inequality (28, 29). Furthermore, private education spending has been shown to increase income inequality over time across multiple countries, whereas public education spending has been shown to reduce it (30). In healthcare, private spending is also higher in more unequal countries (31) and an increase in the share of private (vs. public) spending has similarly been shown to increase income inequality over time (32). And in the context of climate change, poorer individuals unable to afford private solutions are often disproportionately affected by disasters (33–36). In summary, the private solution trap is becoming increasingly apparent across multiple domains (37, 38).

Despite the wide availability of private solutions in the modern world, there have been only three empirical studies that have directly aimed to identify the complex dynamics of the private solution trap (14–16). What these studies have consistently found, using a "private–public goods game", is that introducing private solutions fundamentally transforms the structure of collective action problems. The first study showed that individual preferences for private solutions bring about inefficient resource allocations and group coordination failures across multiple cost–benefit ratios of private vs. public solutions—an outcome described as a "modern tragedy of the commons" (14). The second study found that private solutions undermine support for public solutions and exacerbate wealth inequality within groups, particularly when access to private solutions is unequal (15). The third study showed that groups are often willing to abolish private solutions, which serves to increase support for public solutions and reduce wealth inequality (16).

There are, however, limitations to this body of research that we address in this preregistered study (https://osf.io/3ubt9/). One limitation is that these studies have not assessed the effect of different origins of wealth, even though other authors have noted the positive relationship between a population's beliefs that luck (vs. hard work) determines life outcomes and its government's social spending (i.e., on public solutions) as a proportion of Gross Domestic Product (GDP) (39); and that citizens' beliefs that wealth differences are deserved go hand-in-hand with the level of inequality in their country (40). Another limitation is that previous findings relating to the private solution trap are based on a Western, Educated, Industrialized, Rich, and Democratic (WEIRD) (41) student sample in the Netherlands. It is therefore unclear whether these findings a) are sensitive to different origins of wealth; b) extend to non-WEIRD populations; and c) are influenced by cultural values and other socioeconomic factors.

The origin of wealth is rarely manipulated in empirical studies of collective action problems, where higher or lower endowments are generally assigned randomly to participants. Under these conditions, participants receiving higher endowments tend to contribute more to private solutions (15, 16) and proportionally less to public solutions (42–46). However, different origins of wealth can influence preferences for private and public solutions by shaping views about whether inequality is fair, which may depend on whether the better-off are seen as deserving on account of merit or simply lucky (47, 48). For example, people with "libertarian" or "egalitarian" fairness views see merit- and luck-based inequality as equally fair or unfair, whereas those with "meritocratic" fairness views perceive merit-based inequality as fairer and may therefore be less motivated to support public solutions that reduce it (39, 40, 49–54). Previous studies investigating the effects of different origins of inequalities in collective action problems have found greater support for public solutions when luck (vs. merit) determines unequal vulnerability to a collective risk (55) but not when it determines unequal wealth (56). Here, we investigated whether preferences for both public and private solutions were influenced by different origins of wealth.

Preferences for private and public solutions may also depend on cultural values, which express shared conceptions of what is good in a society (57). Several prominent theories of cultural values exist, many of which overlap (58–67), suggesting that they capture robust aspects of cultural differences (68–70). In particular, Schwartz's theory of cultural value orientations provides a rich framework by identifying three dimensions on which societies differ: 1) autonomy vs. embeddedness describes the extent to which people are considered autonomous individuals vs. entities embedded in the collectivity; 2) hierarchy vs. egalitarianism describes cultures in which socially responsible behavior is encouraged via the unequal vs. equal distribution of power and resources; and 3) mastery vs. harmony describes the degree to which people are encouraged to change rather than accept the natural and social environment to attain goals (58).[‡] Here we explored whether these cultural values could explain preferences for private and public solutions. One possibility was that autonomy, hierarchy, and mastery values (which can respectively justify notions of independence, inequality, and competition) would be positively associated with preferences for private solutions and that embeddedness, egalitarianism, and harmony values (which are more aligned with interdependence, equality, and cooperation) would be positively associated with preferences for public solutions.

[*]Previous researchers have referred to the "dilemma of self-reliance" (15, 16) to describe situations in which private solutions are available. We use the "private solution trap" to refer to undesirable outcomes (outlined below) that may arise from such dilemmas. Other related traps associated with the provision of public goods not discussed here include the "public goods trap" (112) and the "weak state trap" (113).

[†]While private solutions at an institutional level may feature lower-level social dilemmas involving multiple individuals, they remain "private" in the sense that they are excludable and primarily benefit the implementing institution rather than all parties involved in the collective action problem at hand.

[‡]Scores on each of these dimensions have been calculated for 80 countries and were published in 2008 (114). They were not available for four countries in our sample: the Dominican Republic, Honduras, the United Arab Emirates, and Uruguay.

Evidence on whether cultural values predict behavior in collective action problems is mixed. Some studies report minimal variation across countries (71–76), whereas others find different levels of contributions to public goods between cultural regions, particularly when enforcement mechanisms such as peer punishment are introduced (77–82). Beyond cultural values, the effects of other socioeconomic factors have also been explored. There is evidence that trust tends to increase contributions to public goods (83); income inequality tends to decrease them (84); ethnic and linguistic diversity undermines public solution provision (85, 86); globalization promotes contributions to global but not local public goods (87); and differences in material security, religiosity, and pathogen stress do not explain trust or cooperation across cultures (76). Importantly, this body of research has focused almost exclusively on decision-making in relation to public solutions. Whether these sociocultural factors –among others–shape preferences for private solutions therefore remains unknown.

The Private–Public Goods Game. In the original version of this game (14), participants were assigned to groups of four and given resource points in each of 10 rounds that they could cumulatively invest in a private and/or public solution (or keep for themselves). After the 10th round, participants kept any points not invested if a) they had invested enough in their private solution to reach a predefined private target; or b) their group had collectively invested enough in the public solution to reach a predefined public target. If group members failed to invest enough in the private or public solution to reach either target they lost all remaining points.

In our adapted version of the game (see also refs. 15, 16, 43, 55, and 56), participants were assigned to groups of four made up of two "rich" players who received an endowment of 120 Monetary Units (MU) and two "poor" players who received an endowment of 80 MU. In each of 10 rounds they could invest up to 20 MU in a private solution (costing 60 MU) and/or a public solution (costing 160 MU). As in the original version of the game, group members kept any MU not invested if they reached either the private or public solution target (or both) within the 10 rounds and lost all remaining MU otherwise. The game parameters meant that the most economically efficient approach was for all group members to invest only in the public solution, which—if they achieved it—would collectively leave them with 240 MU. If instead all group members invested only in their private solution, they would have only 160 MU between them at the end of the game. And if group members did not invest sufficiently in either solution, they would end up with 0 MU. Before the game, participants completed a series of comprehension questions and were asked what they thought would be a fair contribution toward the public solution from rich and poor players.

This design enabled us to test the effect of participants' level of wealth (rich vs. poor) on their preferences for private and public solutions. In addition, we randomly assigned groups to one of three treatments, which enabled us to test the effect of different origins of wealth. In the merit treatment, participants' endowments were determined by their performance in a pregame effort task, whereby the two highest-scorers in each group became rich and the two lowest-scorers became poor (see *Materials and Methods*). In the luck treatment, they were determined via a lottery. These treatments were designed to generate contrasting beliefs about deservingness and fairness described above. In the uncertain treatment, endowments were determined either by effort task performance or the lottery—but participants did not know which. This third treatment was designed to represent the real world, where inequality invariably emerges from a combination of merit and luck. Participants were informed about whether their endowment would be determined by merit or luck (or one of the two) before they completed the effort task. After completing the task and learning their endowment, they were reminded how it was determined, as in previous similar studies (55, 56). This ensured that they knew they were rich or poor on account of merit, luck, or either merit or luck. Our preregistered hypotheses were that these different levels and origins of wealth would influence private solution adoption, public solution provision, and contributions to both solutions. When testing these hypotheses, private solution adoption and public solution provision were treated as binary variables, whereas contributions were treated as continuous. In addition, our preregistration included hypotheses regarding the role of fairness views and first-round contributions to both solutions. For conciseness, we report results for these hypotheses in the *SI Appendix*.

We tested the effect of sociocultural factors by recruiting 7,504 participants from 34 diverse countries (see *SI Appendix* for sample size rationale). The countries in our sample covered almost the whole available worldwide range of the seven cultural value orientation scores that make up the three Schwartz dimensions. Under mastery vs. harmony, for example, harmony scores in our sample ranged from 3.46 to 4.62 (worldwide range: 3.28 to 4.62) and mastery scores ranged from 3.66 to 4.41 (3.60 to 4.41; see *SI Appendix*, Table S2 for coverage of all cultural dimensions). In addition, our sample included at least one country from each cultural region identified by prominent theorists (58, 88). Based on World Values Survey data (89), it included the country with the fifth-lowest level of trust in the world (Colombia, where 4.5% believe that most people can be trusted) and the country with the highest level of trust (Denmark, 73.9%). It also included the country with the highest (South Africa) and fourth-lowest level of income inequality (India) (90). Our analysis of cultural values and socioeconomic factors was exploratory and not preregistered.

While our sample was made up of university students who may not have been fully representative of their respective societies, they were likely to have been exposed to the cultural values of these societies (91). Consistent with this reasoning, students have exhibited similar patterns of behavior to more representative samples in comparable studies (92, 93). Furthermore, by recruiting student subjects who had relatively similar age, education, and socioeconomic profiles across societies, we minimized confounds to our outcomes that would have arisen from more diverse general population samples; and therefore maximized the likelihood that cross-country differences could be attributed to cultural factors (78, 82, 94). In this way, the cultural diversity of our participant pool enabled us to test the generalizability of the private solution trap. Furthermore, it enabled us to search for universal pathways to public solutions, by which we mean patterns of behavior—such as early contributions toward public solutions (14, 43, 78, 95) and conditional cooperation (96, 97)—that supported public solution provision across the world. This analysis was also exploratory and not preregistered. In the context of global collective action problems such as climate change mitigation, however, identifying such pathways is critical.

In summary, in this study, we adapted the private–public goods game to examine how the level and origin of people's wealth jointly influenced preferences for private and public solutions alongside other sociocultural factors across 34 countries, including both WEIRD and non-WEIRD samples.

Results

Collective Welfare. We defined collective welfare as the total amount of wealth within the group at the end of the game, after taking losses from players' failing to achieve either solution into

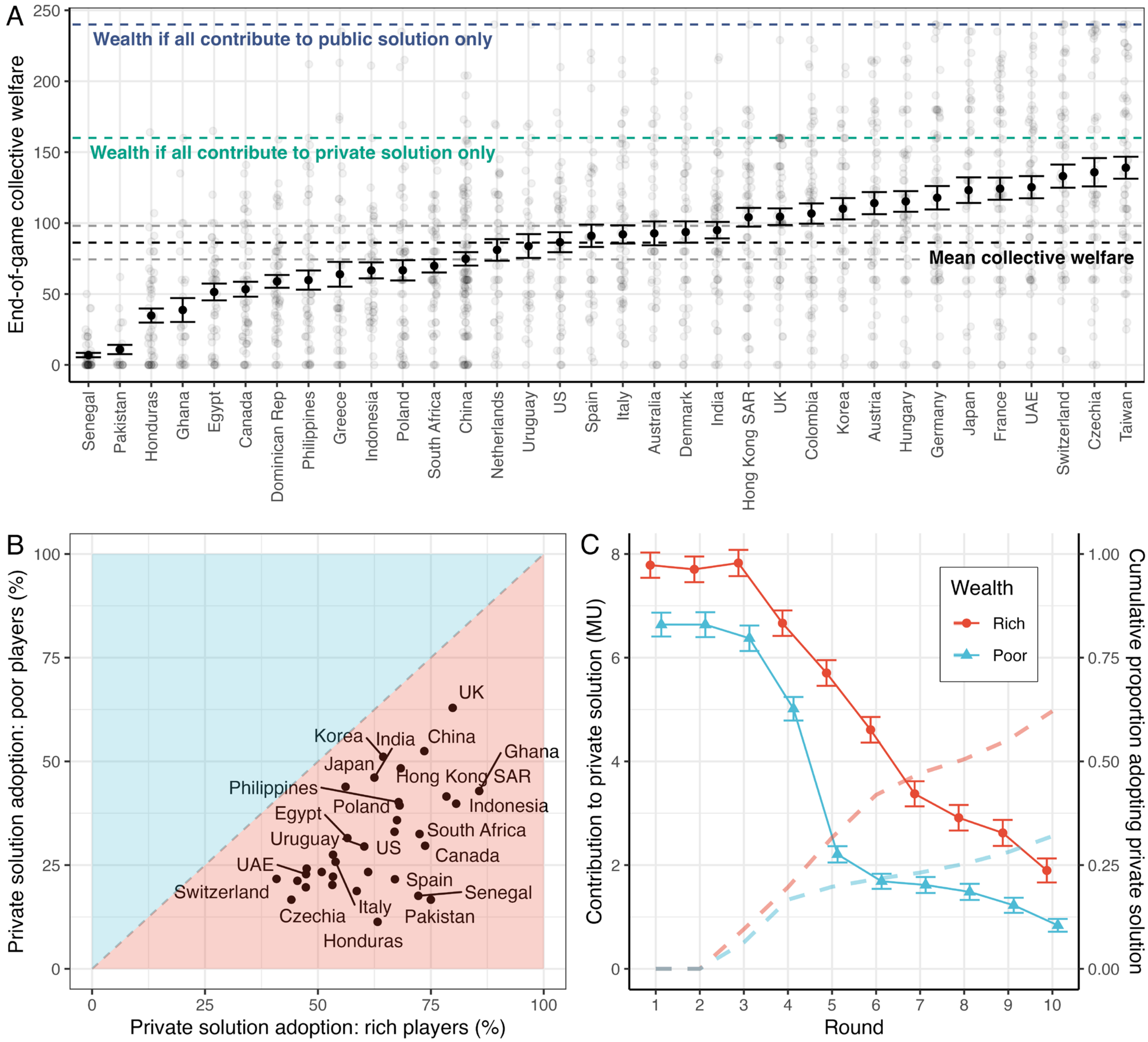

Fig. 1. Collective welfare and private solution adoption across countries and wealth levels. Plot (*A*) shows collective welfare, defined as the total wealth in MU in groups in each country at the end of the game. Points in the background represent groups; black points show raw means, and error bars represent 95% CI. The blue dashed line highlights the total amount of wealth at the end (240 MU) if all group members contributed only to the public solution. The green dashed line highlights the total wealth if all group members contributed only to the private solution (160 MU). The black dashed line represents the model-estimated mean collective wealth within groups at the end of the game (86 MU) with gray dashed lines representing 95% CI. Plot (*B*) shows raw mean private solution adoption rates among rich and poor players in each country. The red shaded area below the gray dashed 45° line shows countries in which rich players adopted the private solution more often than the poor. Plot (*C*) shows mean contributions (in MU) toward the private solution by rich and poor players as solid dots and triangles. Contributions made after the private solution had been adopted are excluded, and error bars represent 95% CI. Dashed colored lines represent the cumulative proportion of rich (red) and poor (blue) players who had adopted the private solution after each round.

account (Fig. 1*A*). Groups (n = 1,876) collectively earned an estimated average of 86.2 MU (95% CI [74.39, 98.10]; linear mixed-effects model (LMM) with country random intercepts). This was significantly lower than the benchmarks corresponding to exclusive contributions to public solutions [240 MU: $t(33) = -26.4$, $P < 0.001$] and private solutions [160 MU: $t(33) = -12.7$, $P < 0.001$]. Out of all the groups, just 15 (0.8%) collectively took home the full 240 MU, and just 11 (0.6%) collectively took home 160 MU by contributing exclusively to private solutions. In other words, few groups perfectly coordinated on either one solution or the other: Out of the 1,151 groups who provided the public solution, 917 (79.7%) also featured some level of private solution adoption (i.e., by at least one player). Furthermore, collective welfare showed a nonlinear relationship with private solution adoption within the group. Shared wealth was estimated to be highest in groups in which no players adopted the private solution (167 MU), lowest in groups in which three did so (54 MU), and slightly higher in groups in which all four players did so (76 MU) (LMM with country random intercepts; linear term: $\beta = -82.81$, 95% CI [−87.94, −77.68], $P < 0.001$; quadratic term: $\beta = 15.01$, 95% CI [13.80, 16.21], $P < 0.001$). The inclusion of this quadratic term significantly improved model fit [likelihood-ratio test: $\chi^2(1) = 516.91$, $P < 0.001$].

Private Solution Adoption. Overall, 47.0% of players adopted the private solution. In all 34 countries, a higher proportion of rich players (62.1%) than poor players (32.0%) did so (Fig. 1*B*).

We assessed the effect of player wealth on private solution adoption with a generalized LMM (GLMM) that accounted for group- and country-level variability. Results indicated that the odds of adopting the private solution were approximately five times higher for rich than for poor players (*OR* = 5.00, 95% CI [4.15, 6.02], $P < 0.001$, conditional $R^2 = 0.32$; see *SI Appendix*, Table S8). Fig. 1*C* highlights how rich players also contributed more to the private solution than poor players in every round of the game.

Private solution adoption rates were almost the same in the merit (46.8%), uncertain (47.3%), and luck (47.1%) treatments. Compared with the merit treatment, the odds of private solution adoption were no higher in the uncertain treatment (*OR* = 1.04, 95% CI [0.90, 1.20], $P = 0.580$) or the luck treatment (*OR* = 1.02, 95% CI [0.88, 1.17], $P = 0.827$; GLMM with country and group random intercepts, $n = 7{,}504$). Furthermore, private solution adoption rates were similar across treatments among rich players (merit 62.7%; uncertain: 61.6%; luck: 62.0%) and poor players (merit: 30.9%; uncertain: 32.9%; luck: 32.1%). GLMMs with fixed wealth and treatment effects revealed a positive effect of wealth (as reported above) but no treatment effect or treatment x wealth interaction (*SI Appendix*, Table S9). In summary, different levels of wealth (rich vs. poor) influenced preferences for private solutions, whereas different origins of wealth (merit vs. luck vs. uncertain) did not.

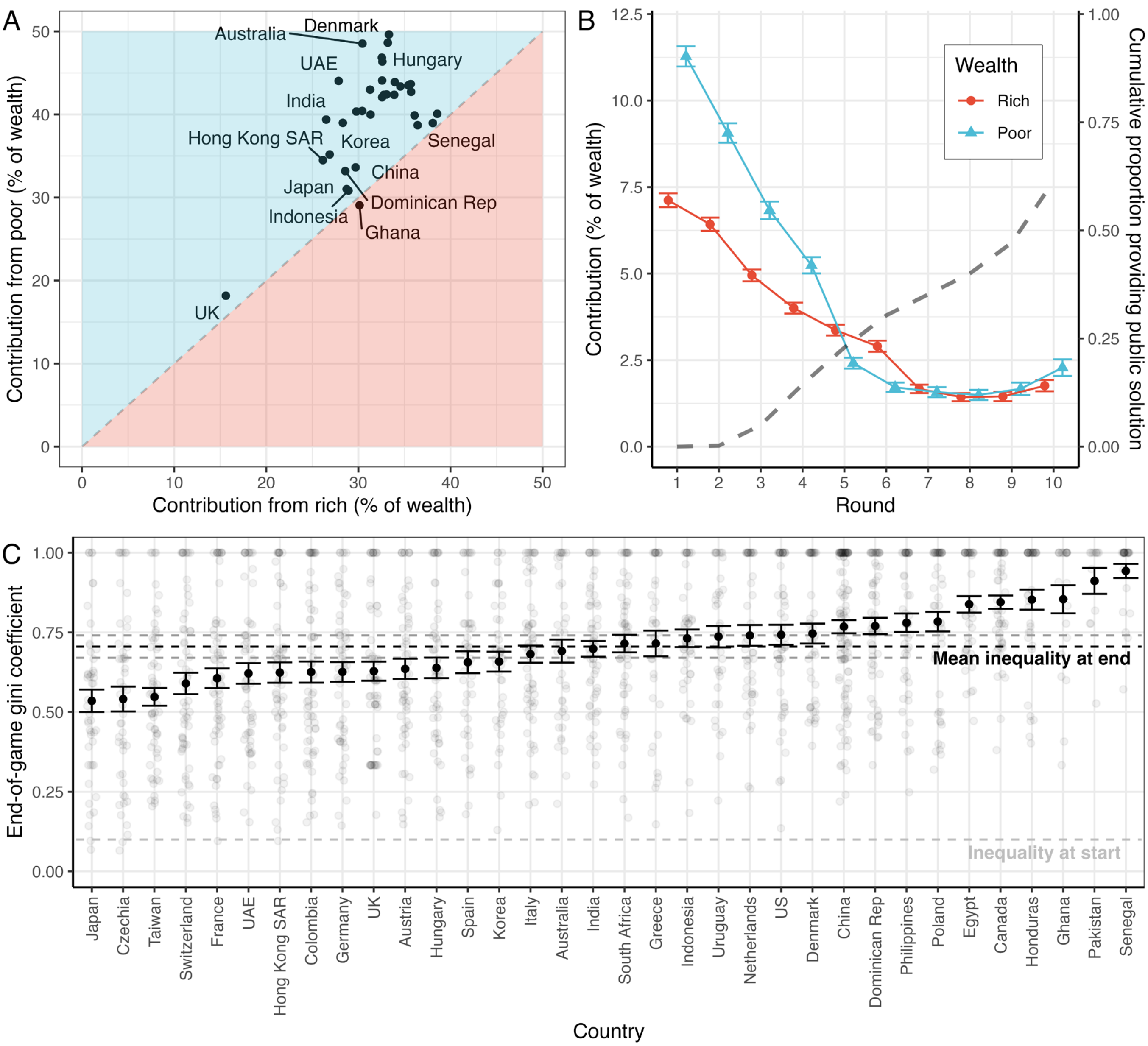

Fig. 2. Public solution contributions and wealth inequality. Proportional contributions toward public solutions from rich and poor players and the consequences for wealth inequality within groups. Plot (*A*) shows the raw mean proportions of wealth contributed toward the public solution from rich and poor players in each country. Points in the blue (red) shaded area above (below) the gray dashed 45° line are countries in which proportional contributions from poor (rich) players were higher than those from rich (poor) players. Plot (*B*) shows mean contributions as a proportion of wealth at the start of each round from rich and poor players. Contributions made after the public solution had been provided are excluded, and error bars represent 95% CI. The dashed gray line represents the cumulative proportion of groups that had provided the public solution after each round. Plot (*C*) shows the level of wealth inequality within groups at the end of the game as represented by the Gini coefficient. Points in the background represent groups. The gray dashed line shows the level of wealth inequality within groups at the start of the game ($G = 0.10$); the black dashed line shows the same at the end of the game ($G = 0.71$). Error bars represent 95% CI.

Public Solution Contributions. Before the game, participants judged it fair that rich players contribute 42.7% of their wealth toward the public solution and poor players contribute 40.3% of theirs (*SI Appendix*, Fig. S2*A*). During the game, rich players in total contributed proportionally less than poor players in almost every country (Fig. 2*A*). On average, they contributed 31.3% of their wealth (37.6 MU), whereas poor players contributed 39.8% of theirs (31.8 MU). Poor players' contributions were therefore more closely aligned with participants' pregame fairness judgments, although these fairness judgments varied according to participants' own level of wealth (*SI Appendix*, Fig. S2*B*) and origin of wealth (*SI Appendix*, Fig. S2*C*).

We assessed differences in public solution contributions from rich and poor players using a LMM with fixed wealth and round effects, random intercepts for countries, groups, and individuals, and random slopes for the effect of wealth across countries. Results indicated that poor players on average contributed 1.28 percentage points more of their wealth than rich players in each round (β = 1.28, 95% CI [1.02, 1.54], P < 0.001, conditional R^2 = 0.33, n = 60,396 player-round observations; see *SI Appendix*, Table S11). Fig. 2*B* highlights how these differences in contribution behavior were more pronounced during the first four rounds of the game. They also emerged regardless of the origin of wealth (*SI Appendix*, Fig. S3), meaning we did not detect any treatment effects or treatment x wealth interaction effects on contributions to the public solution (*SI Appendix*, Table S12). Consequently, public solution provision rates were equivalent across treatments (luck: 63.6%; uncertain: 59.5%; merit: 60.8%): Compared with groups in the luck treatment, groups were no less likely to achieve the public solution in the uncertain treatment (*OR* = 0.83, 95% CI [0.65, 1.05], P = 0.126) or the merit treatment (*OR* = 0.89, 95% CI [0.70, 1.13], P = 0.332; GLMM with country random intercepts, n = 1,876).

Increasing Wealth Inequality. At the start of the game, wealth inequality (as measured by the Gini coefficient) was the same in every group (G = 0.10). At the end of the game, we recalculated Gini coefficients after taking losses resulting from failures to achieve either the private or public solution into account. After excluding groups with zero collective welfare, the mean level of wealth inequality within groups was estimated to be G = 0.71 (95% CI [0.67, 0.74], LMM with country random intercepts, n = 1,734). This was significantly higher than the benchmark level of inequality at the start of the game ($t(33)$ = 35.07, P < 0.001). To put this into perspective, earnings inequality after the game was higher than in a country like South Africa (G = 0.63), which is currently one of the most unequal countries in the world (90). Furthermore, Fig. 2*C* shows that this trend toward increasing wealth inequality emerged in every country. The level of inequality within each country was positively correlated with real-world levels of inequality in each country, but not to the point of statistical significance (r = 0.22, 95% CI [−0.14, 0.53], P = 0.216).

One explanation for this universal trend toward increasing inequality was that groups often failed to coordinate on the public solution and left some players unprotected. In particular, poor players were left unprotected more often (15.7%) than rich players (6.4%). After accounting for group-level variability (country-level variance was estimated as zero), the odds of poor players losing everything were estimated to be more than five times higher than they were for rich players (*OR* = 5.28, 95% CI [4.16, 6.71], P < 0.001; LMM, n = 7,504). Importantly, the number of unprotected players within the group was associated with higher levels of inequality (unprotected poor: β = 0.15, 95% CI [0.12, 0.19], P < 0.001; unprotected rich: β = 0.11, 95% CI [0.10, 0.13], P < 0.001, n = 1,734; LMM with country random intercepts, see *SI Appendix*, Table S13). This was partly due to the way that the Gini coefficient is calculated, however, which mechanically increases with the number of unprotected players (unless everyone is left unprotected).

A second explanation for the universal increase in wealth inequality was higher rates of private solution adoption among rich players (β = 0.07, 95% CI [0.06, 0.09], P < 0.001) and, to a lesser extent, poor players (β = 0.03, 95% CI [0.01, 0.05], P < 0.001, n = 1,734, LMM with country random intercepts). In contrast, wealth inequality within groups could not be explained by poor players contributing proportionally more than rich players to the public solution (β = 0.00, 95% CI [−0.00, 0.00], P = 0.582; same LMM, see *SI Appendix*, Table S13).

Preferences for Private and Public Solutions across Countries. Among all cross-country factors assessed, only Schwartz's cultural value orientations helped explain preferences for both private and public solutions across countries. For this exploratory analysis, we standardized all sociocultural predictors and used a conservative Bonferroni–Holm correction for multiple hypothesis testing. We found that the odds of participants adopting the private solution were lower in countries that scored higher on harmony values (*OR* = 0.74, 95% CI [0.64, 0.84], P < 0.001) and higher in countries that scored higher for hierarchy values (*OR* = 1.34, 95% CI [1.14, 1.57], P = 0.015) and mastery values (*OR* = 1.31, 95% CI [1.11, 1.54], P = 0.044; GLMMs with group and country random intercepts, n = 6,648). Conversely, the odds of groups adopting the public solution were higher in countries scoring higher on harmony values (*OR* = 1.58, 95% CI [1.23, 2.02], P = 0.011) and lower on hierarchy values (*OR* = 0.63, 95% CI [0.48, 0.83], P = 0.044; GLMM with country random intercepts, n = 1,662). As shown in Fig. 3, private solution adoption across countries correlated negatively with harmony values (r = −0.63, 95% CI [−0.81, −0.34], P < 0.001) and positively with hierarchy (r = 0.53, 95% CI [0.20, 0.74], P = 0.003) and mastery (r = 0.49, 95% CI [0.16, 0.72], P = 0.006) values. Public solution provision also correlated positively with harmony values (r = 0.56, 95% CI [0.25, 0.76], P = 0.001) and negatively with hierarchy (r = −0.50, 95% CI [−0.73, −0.18], P = 0.004) and mastery (r = -0.42, 95% CI [−0.68, −0.08], P = 0.020) values. Preferences for private and public solutions also differed between cultural regions (*SI Appendix*, *Supporting Results*). No other sociocultural factors explained private solution adoption (*SI Appendix*, Table S14) or public solution provision (*SI Appendix*, Table S15) or interacted with our treatments to explain these outcomes. It is worth noting, however, that several sociocultural factors were associated with collective welfare (*SI Appendix*, *Supporting Results*).

Universal Pathways to Public Solutions. We identified two universal pathways that helped groups to achieve public solutions across all cultures. The first was first-round contributions toward the public solution. We investigated this using a GLMM that allowed slopes to vary at the country level (*SI Appendix*, Table S18). Overall, each additional 1 MU contributed in the first round was associated with an 11% increase in the odds of public solution provision (*OR* = 1.11, 95% CI [1.10, 1.13], P < 0.001, conditional R^2 = 0.43). Furthermore, country-level slopes varied minimally (SD = 0.01), with odds ratios (ORs) ranging from 1.10 in Pakistan to 1.13 in the United Kingdom (Fig. 4*A*), highlighting the universality of the effect. Consistent with this, average first-round contributions strongly predicted overall public

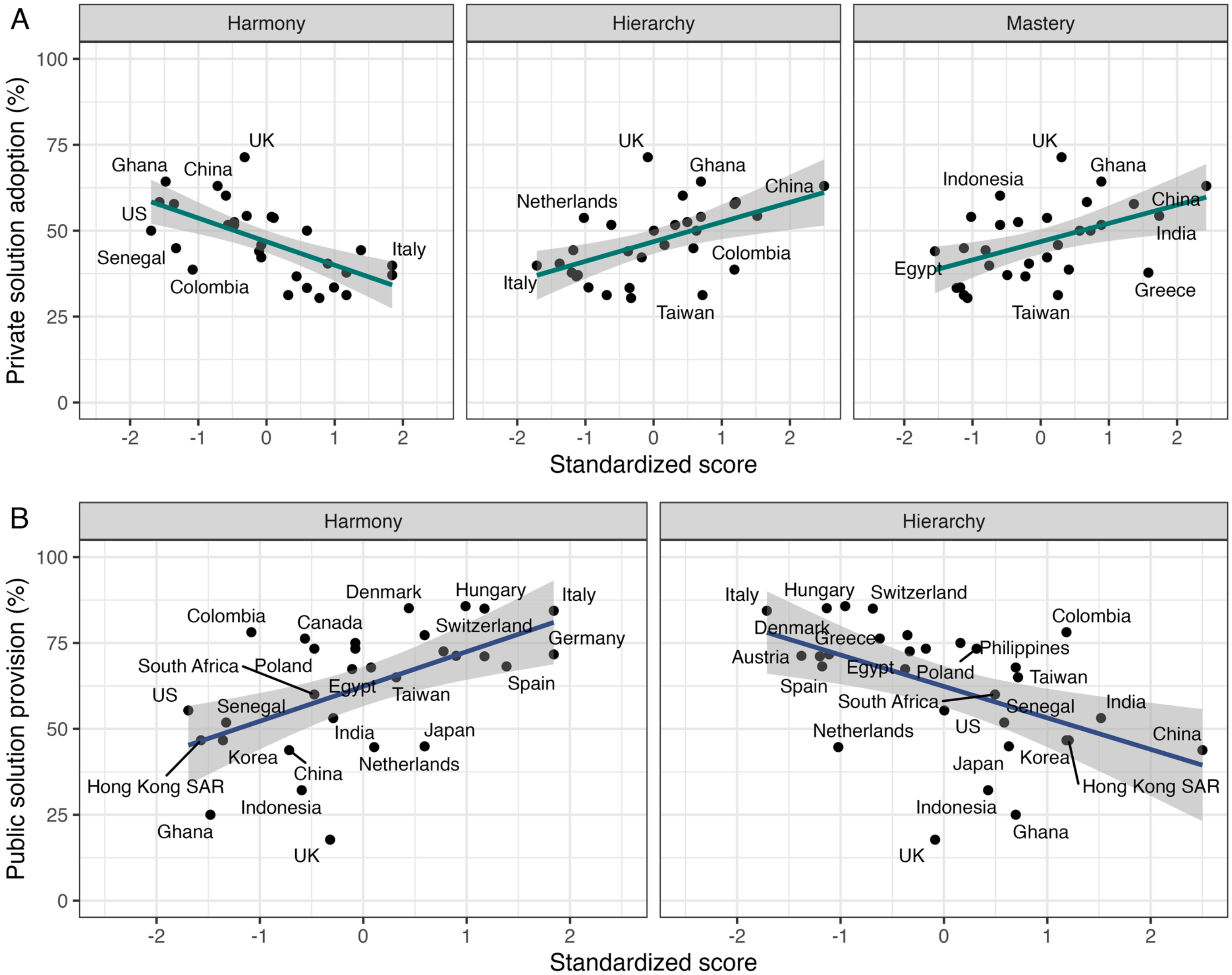

Fig. 3. Schwartz cultural values underpinning private solution adoption and public solution provision. Plot (*A*) shows the Schwartz cultural values that were negatively (harmony) and positively (hierarchy and mastery) associated with private solution adoption rates across countries. Plot (*B*) shows the values that were positively (harmony) and negatively (hierarchy) associated with public solution provision. Points represent country-level means, and lines show unadjusted trends for visualization.

solution provision rates across countries (r = 0.90, 95% CI [0.81, 0.95], P < 0.001, n = 34; see also ref. 14).

The second universal pathway was conditional cooperation. Following previous authors (82, 98) we classified players as conditional cooperators if we detected a positive correlation (i.e., $r \geq 0.5$) between their contributions toward the public solution and average contributions from their group members in the previous round (see *SI Appendix* for classification of other types). We then assessed whether the number of conditional cooperators within a group was universally associated with higher rates of public solution provision using a GLMM that allowed slopes to vary across countries, as above. Each additional conditional cooperator within a group was associated with a 56% increase in the odds of public solution provision (OR = 1.56, 95% CI [1.33, 1.82], P < 0.001, conditional R^2 = 0.18, n = 1,876; see *SI Appendix*, Table S20). While the country-level slope variance was higher (SD = 0.34) than it was for first-round contributions, the effect of additional conditional cooperators was positive in every country except Senegal, with positive ORs ranging from 1.07 in Honduras to 2.62 in the United Kingdom (Fig. 4*B*). In addition, the average proportion of conditional cooperators was positively correlated with public solution provision rates across countries (r = 0.55, 95% CI [0.25, 0.75], P < 0.001, n = 34). Together, these results highlighted the largely universal effects of first-round contributions and conditional cooperation on public solution provision.

Discussion

Our results highlight the potential consequences of the private solution trap whereby the existence and widespread adoption of private solutions undermine the provision of collectively optimal public solutions, while also increasing wealth inequality and leaving less-wealthy individuals unprotected against collective risks. Consistent with previous results (14–16), the adoption of private solutions reduced collective welfare and was more common among rich players, who also contributed proportionately less toward public solutions. These previous results therefore extended to both WEIRD and non-WEIRD populations across the world, highlighting the generalizability of the private solution trap. In addition, we replicated previous findings regarding the relationship between private solution adoption and wealth inequality (15, 16). Wealth inequality within groups increased in all 34 countries, and this was driven in

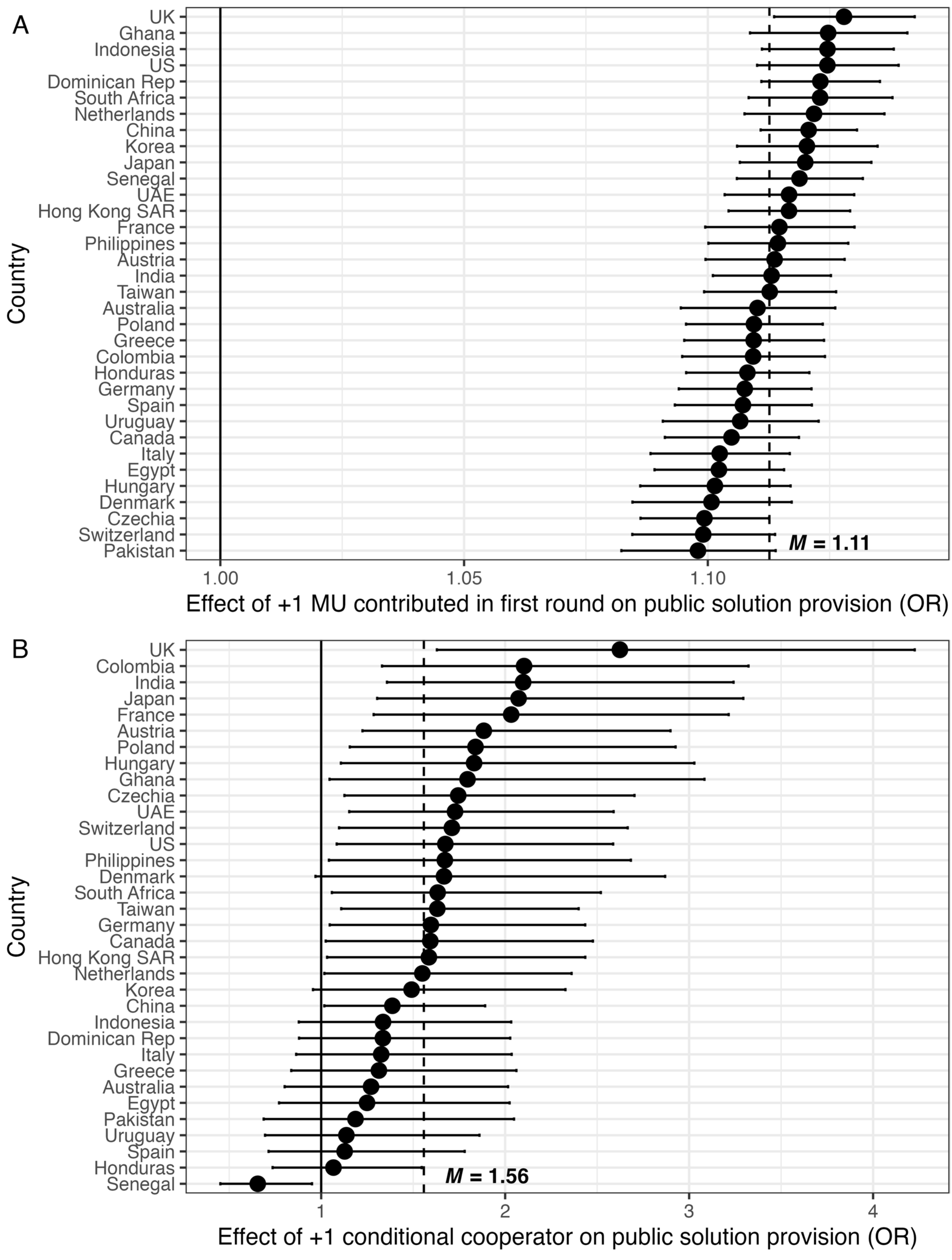

Fig. 4. Universal pathways to public solutions. Plots show ORs of public solution provision as a function of one additional MU being contributed by the group in the first round (*A*) and there being one additional conditional cooperator in the group (*B*). Points represent country-specific effects from mixed-effects models with random slopes by country. Error bars show 95% CI. Black solid lines indicate no effect (OR = 1). Black dashed lines represent overall effects across all countries.

particular by rich players adopting private solutions and poor players being left unprotected. This finding mirrors several real-world examples of the private solution trap (30, 37, 38).

Our finding that contributions to public solutions were unaffected by different origins of wealth was also consistent with previous research (56). In the present study, contributions to private solutions were similarly unaffected by different origins of wealth. One possible explanation is that many participants held libertarian or egalitarian (rather than meritocratic) fairness views and therefore perceived luck- and merit-based inequality to be equally fair or unfair (48). However, the widespread endorsement of meritocratic views in participants' fairness judgments (*SI Appendix*, *Supporting Results*) suggests that this is unlikely. More likely, given that we observed differences in fairness judgments (but not in-game behavior) between treatments, the salience of the origin of wealth was overridden by strategic considerations that emerged during our multiround game. In other words, participants' focus likely shifted away from their fairness views and toward their response to other group members' decisions once the game began, similar to how social preferences and personality traits often lose predictive power in repeated dilemma games (99–102). Though it may be the case that one-shot games without feedback on peer behavior provide a suitable environment for investigating the effects of different origins of wealth, we propose that behavior in repeated games—which provide greater external validity for situations featuring repeated interactions—is more generalizable to real-world settings, and that the role of social preferences, personality traits, and fairness views in such situations may have been overemphasized by studies relying on one-shot games. Our findings imply that drawing people's attention to the luck-based origins of their wealth is unlikely to significantly shift their preferences away from private solutions and toward public solutions in repeated social interactions.

The observed associations between Schwartz's cultural value orientations (58) and preferences for private and public solutions across countries highlight the potential explanatory power of this framework. This evidence for cross-cultural differences in behavior is consistent with some studies (77, 81, 82) but not with others (71, 75, 76). One possible explanation for this inconsistency is that these previous studies have rarely considered all, if any, of these cultural value orientations. Another possibility is that Schwartz's approach—identifying what is normatively conceived as good in a society—overcomes limitations associated with other cross-cultural methods that may result in people comparing themselves with reference groups (68, 103, 104). Our finding that private solution adoption was higher in countries with cultures emphasizing hierarchy and mastery and lower in those emphasizing harmony mirrored our finding that public solution provision was higher in countries with stronger harmony values and lower in countries with stronger hierarchy values. These findings reflect the distinct motivational emphases of these cultural values: While hierarchy and mastery values justify inequalities and self-assertion, which may justify the adoption of private solutions, harmony values emphasize cooperation and interdependence, which may encourage public solution provision and discourage private solution adoption. Regarding Schwartz's third dimension of cultural values (autonomy vs. embeddedness) we might have expected the former to be associated with private solution adoption and the latter with public solution provision, but we did not find evidence for this. Nonetheless, our results highlight how the normative cultural values that are implicitly and explicitly taught and learned in educational and social settings across the world may be relevant in global collective action problems.

Despite the many sociocultural differences between countries, early contributions toward public solutions and conditional cooperation consistently supported public solution provision across the world. Our identification of these "universal pathways" toward public solutions adds to the evidence base regarding the impact of these behavioral patterns (14, 43, 78, 95, 105) and may serve as inspiration for policymakers aiming to develop institutions or interventions in a range of collective action problems. In the context of global climate change mitigation, these could include climate clubs (11) or matching mechanisms (106) to encourage early and reciprocal contributions, both of which may help groups to avoid decreases in contributions toward public solutions, as we observed in particular during the first five rounds of our experiment.

The implications of our findings are naturally limited by the extent to which it is possible to generalize our results from a simple abstract game to global collective action problems such as climate change mitigation. The private–public goods game was not designed to perfectly mirror such problems, which involve countless complexities, but instead to highlight factors that may be relevant to individual decision-making and group outcomes in real-world situations. In addition, our findings are limited by the possibility that the observed variation across populations reflected differences in participant understanding (107, 108). While we aimed to minimize this possibility by instructing all participants equivalently (109), it is likely that participants from WEIRD and non-WEIRD samples had different levels of familiarity with experimental games. As a result, differences in behavior may have reflected different interpretations of the game (41, 110). Nonetheless, our main findings were robust across our highly diverse sample. Together, they highlight how the joint existence of private solutions and inequality can easily lead to a trap—but, as we have shown, it is one that can be avoided.

Materials and Methods

We recruited 7,504 participants, all of whom provided informed consent, from student populations in 34 countries, which equated to an average of 55 groups of four ($n = 220$) in each country (*SI Appendix*, Table S3).[§] We achieved our preregistered aims of recruiting 240 participants in 20 countries or at least 180 participants in a further 10 countries. We deviated from our preregistration in four countries where recruiting 180 participants was not possible (Spain: $n = 176$; Uruguay: $n = 156$; Ghana: $n = 112$; and Pakistan: $n = 96$).[¶] Ethical approval for the full study protocol was provided by local university committees as required (see *SI Appendix* for details of all approving committees). Local researchers conducted experimental sessions in either lab or online settings and all followed the same set of procedural instructions to ensure consistent implementation across countries. Participants were randomly assigned to groups of four, which were randomly assigned to the luck, merit, or uncertain treatment. They first completed a 5-min effort task consisting of adding up sequences of five random numbers from 1 to 100 (e.g., 81 + 25 + 2 + 52 + 13 = ?) in which they earned points for correct answers. For groups in the merit treatment, participants' starting endowments were determined by their performance in the effort task, with the two highest-scorers becoming rich and the two lowest-scorers becoming poor. For groups in the luck treatment, participants' endowments were determined by a computer-generated lottery. For groups in the uncertain treatment, endowments were determined either by effort task performance or by a lottery; task performance was chosen for two players, with the higher-scoring player becoming rich, and the lottery was chosen for the other two players, with one becoming rich and one poor. Participants were informed about these allocations before completing the task. After completing this task, participants received their endowment (120 MU or 80 MU) and were reminded of its origin. They then received instructions for the game. After answering four comprehension questions, they stated what they judged would be a fair contribution toward the public solution from rich and poor players. Participants had to answer the comprehension questions correctly in order to proceed to the game, in which they made anonymous contributions toward the public and private solutions (up to 20 MU in total) in each of 10 successive rounds. Unlike in the original version, participants received all their MU at the start of the game (but could only invest up to a total of 20 MU in each round); and at the start of each round they were informed only about their own investment decisions and the total amount invested in the public solution by the group. These minor changes were designed to improve external validity by capturing the perspective of governments allocating climate change budgets over multiyear

§We also recruited one general population sample from the UK (*SI Appendix*, Fig. S6 and *Supporting Results*).

¶We include data from these countries because our main results concern overall differences across (rather than within) countries (see *SI Appendix*, *Supporting Text* for sample size rationale and further discussion).

periods. At the end of the game, participants answered a series of demographic questions and learned their final earnings. Experimental sessions generally lasted 30 to 40 min and participants on average earned £5.20 (*SI Appendix*, Table S4). Further methodological details can be found in *SI Appendix*.

Data, Materials, and Software Availability. Anonymized data and analysis code have been deposited in OSF (https://osf.io/zg8nj/) (111).

ACKNOWLEDGMENTS. We thank attendees at several conference and seminars for their suggestions, including those at the International Association for Research in Economic Psychology (IAREP) / Society for the Advancement of Behavioral Economics (SABE) Conference, the Economic Science Association Global Meeting, the annual SAET Conference, and the Decision Research @ Warwick Forum in 2023; and the IAREP/SABE Conference, the Workshop on Behavioural Economics hosted by the University of Sheffield; and the European Association of Environmental and Resource Economists Annual Conference in 2024. We would also like to thank Simon Gächter at the University of Nottingham and Gordon Brown and Sidney Sherborne at the University of Warwick for their support and feedback. This research was funded by local universities in each country, with certain exceptions: Loyola Behavioral Lab funded data collection in multiple countries, and the University of Hamburg funded data collection in Egypt. J.W. gratefully acknowledges financial support from Tamkeen under the NYU Abu Dhabi Research Institute Award CG005. A.T. acknowledges funding from the European Research Council (ERC) under the European Union's Horizon Europe program (GREEN TIPPING Consolidator Grant, agreement 101089107). This research was also funded by the following grants: Global Research Priorities, University of Warwick. Spanish Ministry of Science and Innovation (PID2024-156629NB-I00) (P.B.-G., M.A., A.A., F.E., T.G.-M., M.R.-S., C.R., and M.J.V.-D.F.). Spanish Ministry of Science and Innovation (PID2023-147817NB-I00) (J.K.). European Research Council (grant no. ERC-AdG 101020453 PRINCIPLES (E.M.).

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Author contributions: E.M., C.P., D.S., and T.H. designed research; all authors performed research; E.M., C.P., A.A., and F.E. contributed new reagents/analytic tools; E.M. analyzed data; and all authors wrote the paper.

The authors declare no competing interest.

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