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Share the Wealth: Redistribution Can Increase Economic Efficiency

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Abstract People frequently face uncertain income and the threat of loss can inhibit economic investments. Government redistribution can insure citizens against economic losses, but its effect on people's investment decisions depends on how they react to redistributive rules. We apply methods from experimental economics to study how a redistributive institution affects people's investment decisions. Experiment 1 tests whether redistribution can increase economic efficiency when people face risk problems—investment opportunities that are profitable on average but could result in a loss. In a between-subject design, participants decide whether to make a risky investment either individually or under an institution that redistributes earnings equally among four group members. We find greater investment and profits when participants are required to share their earnings. In Experiment 2, we examine free-riding by comparing an institution that allows non-investors to exploit investors to an assortment institution that matches investors with investors. We find that vulnerability to free-riding suppresses investment, whereas an assortment mechanism increases investment by preventing free-riding and thereby facilitating risk pooling.

Keywords Redistribution · Risk pooling · Experimental economics · Experimental political science

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Introduction

Across societies, people confront problems posed by uncertain income (Seabright 2004). Farmers face irregular droughts and floods, workers suffer from unemployment, and entrepreneurs endure volatile demand for their products. Moreover, uncertainty can inhibit investment and productivity. For example, a farmer might forgo a more fertile field because it has a greater risk of flood than a less fertile one. A worker might not invest in specialized training to advance their career because the job market is too unpredictable. Or a medical company might not invest in a new treatment because the chance of failure is too great. In these situations, both the individual and society could benefit on average from the riskier choice, but the threat of failure inhibits investment and makes everyone worse off.

Different societies have a variety of *risk-pooling* institutions that help to overcome these types of problems (reviewed in Seabright 2004). To take a classic historical example, the marine insurance markets developed in seventeenth century London spread the risk of a catastrophic shipwreck between the captain and multiple investors (Ferguson 2008). This allowed them to reap the high profits of maritime trade while curbing the potential downside to any one individual, which would otherwise block many of these opportunities. Similarly, some herders send livestock to each other's territories so that a disaster in one area does not affect their entire stock, which also enables some herders to move into new territories that are more profitable but riskier (Aktipis et al. 2011).

Government redistribution can also function as insurance for buffering risks by transferring wealth from citizens with good economic fortunes to those who suffered hardships (Dworkin 2000; Moene and Wallerstein 2001; Rehm et al. 2012). For example, when a government taxes citizens and then provides benefits to the unemployed, this program spreads the risk of unemployment across everyone by transferring wealth from people who have jobs to those who do not. Moreover, unemployment benefits could encourage citizens to take profitable but risky career paths such as investing in higher education or specialized training.

Although government redistribution can buffer risk, its overall economic benefits are more controversial than private insurance. One key difference is that private insurance is voluntary, whereas government redistribution occurs through mandatory taxes. This also typically means that citizens cannot individually choose their provider, benefit schemes, or their own level of insurance. For these and other reasons, government redistribution is a pervasive and persistent source of political conflict (Aarøe and Petersen 2013, 2014; Acemoglu and Robinson 2005; Bénabou 2000; Feldman and Zaller 1992; Gilens 1999; Huber and Stephens 2001; Meltzer and Richard 1981; Moene and Wallerstein 2001; Petersen 2012; Petersen et al. 2012, 2013). Of course, there are multiple types of redistributive programs with different goals including reducing overall inequality in society, protecting against unexpected hardships, or helping vulnerable groups such as the sick or the elderly. And some redistributive policies receive more political hostility than others (Jensen and Petersen 2016). We focus on one strand of these debates surrounding social

insurance programs: whether mandatory government redistribution can promote investment, similar to private insurance.

We address this question using the methods of experimental political science (Druckman et al. 2006; Gerber and Green 2012; Loewen et al. 2014; McDermott 2002; Morton and Williams 2010; Ostrom 1998; Smith 1982, 2008). Participants play an economic game in which they decide whether to invest money in a profitable but risky venture. In different between-subject conditions, the experimenter imposes different rules of redistribution on players' earnings, mirroring how governments impose involuntary redistribution on citizens. Experiment 1 addresses the basic question of whether mandatory redistribution can in fact promote investment, compared to a baseline condition without redistribution. Experiment 2 then extends this work to investigate another perennial question about government redistribution, its susceptibility to free-riding. We vary the rules of redistribution so that investors are either safe or vulnerable to free-riding by non-investors, and observe how these different rules affect investment.

Can Government Redistribution Increase Economic Efficiency?

In the previous examples about farmers, workers, and ship captains, people face *risk problems*. A risk problem occurs when an investment opportunity is profitable on average (has a positive expected value) but individuals are deterred by the fear of a possible loss. Risk problems can be solved by leveraging the law of large numbers: By subdividing a single gamble into multiple independent gambles, individuals can reduce variance in payoffs to make returns closer to the average profit (Samuelson 1963). In Samuelson's classic example, a friend offers to bet \$200 to \$100 that a coin flip will come up heads. In expectation, the gamble is profitable, netting \$50 profit on average, but half of the time the gambler ends up worse off by losing \$100. However, if the gambler could subdivide the bet into 100 bets of \$2 to \$1, then expected profits are the same, but the chances of losing money are vanishingly small (67 or more tails, $p = .0007$). Samuelson (1963) famously argued that this variance-buffering advantage occurs when a gamble is subdivided, but not if it is only repeated such as taking the original \$200-to-\$100 bet 100 times.

Of course, many important investments cannot be so easily subdivided. A given student can only pursue so many advanced degrees; a given farmer can only cultivate so many different fields. Individual subdividing does not work well in these cases. An alternative strategy for these kinds of problems is *risk pooling* with other people. In risk pooling, multiple people independently make a gamble and then share the payoffs among everyone. In this way, gains and losses are shared so they tend to even out. For instance, multiple farmers could agree to pool risk when cultivating fields that are more fertile but also have greater chances of flooding. Some farmers may suffer from floods but because they are risk pooling, the other farmers share profits with the unlucky farmers. And because the farmers are using the more fertile fields, the average yield is higher than if they each cultivated safer, less profitable fields on their own.

Government redistribution could potentially perform a similar insurance function, except through a mandatory tax rather than a voluntary agreement. For

instance, instead of farmers making their own agreements, the local government could levy higher taxes on the lucky farmers and then redistribute benefits to the unlucky ones. Another example comes from the U.S. Affordable Care Act which imposed several risk-sharing provisions that required health insurers that spent less than expected on medical benefits to contribute some of their gains to the government to be paid out to insurers who spent more than expected.

A growing literature in political economy examines the insurance functions of government redistribution (e.g., Moene and Wallerstein 2001; Rehm et al. 2012). Traditional political economy models assume that government redistribution entails a deadweight loss and reduces economic efficiency, creating an inevitable tradeoff between efficiency and equality (Acemoglu and Robinson 2005; Mankiw 2013; Mirrlees 1971; Okun 1975). However, some researchers have instead examined how redistribution can provide insurance that promotes economic output, efficiency, and growth. For example, Bénabou (2000) argued that redistribution can promote efficiency by overcoming credit-constraints or by serving insurance functions when citizens are risk averse and insurance markets are incomplete. Moreover, Bénabou found that revised models that assume efficient redistribution provide a better fit to cross-national data showing that nations with greater equality also have greater support for government redistribution.

A related literature finds that citizens who are more vulnerable to fluctuating income show greater demand for government redistribution (Kam and Nam 2008; Moene and Wallerstein 2001; Rehm et al. 2012). For example, citizens who invest in specialized training often have less transferrable skills and are at greater risk of unemployment. Iversen and Soskice (2001) found that these more specialized workers show greater support for government spending on unemployment benefits, health care, and pensions.

Although government redistribution could potentially provide insurance, its economic benefits depend in part on whether citizens are encouraged by these safeguards to make more aggressive investments. We discuss and then experimentally test several hypotheses about how investors respond when compulsory redistribution is imposed on them by an authority.

Redistribution and the Psychology of Investment Decisions

We examine three hypotheses about how redistributive rules could affect people's tendency to invest in risky pursuits. The first hypothesis, the *statistical confusion hypothesis*, comes from the behavioral economics literature on statistical reasoning. This research suggests that people might have difficulty recognizing opportunities created by risk pooling through redistribution (reviewed in Kahneman 2011). To know that pooling reduces variance, people would need to correctly understand (consciously or unconsciously) how subdividing a gamble affects variance in payoffs. Moreover, they would need to apply this statistical knowledge to novel situations. People have a poor understanding of statistics in general and of variance in particular (Kahneman 2011; Tversky and Kahneman 1974). Moreover, the relationship between the number of gambles and variance in payoffs, specifically, is very difficult to understand; even professionals have debated whether merely

repeating a gamble is sufficient to reduce variance or if only subdividing the gamble does so (Benartzi and Thaler 1995; Samuelson 1963). Hence there are reasons to doubt whether people understand how risk pooling affects variance in payoffs. This statistical confusion hypothesis holds that people's poor abilities to reason about statistical variance will obscure the benefits of redistribution. Thus, it predicts that redistribution will neither increase nor decrease risky investment.

The second hypothesis, the *demotivation hypothesis*, comes from the economics literature about how redistribution affects people's incentives to invest labor and money toward production. Prominent economists have emphasized that redistribution diminishes the potential rewards of investment (Mankiw 2013; Mirrlees 1971; Okun 1975). If citizens focus primarily on diminished rewards rather than reduced risks, then redistribution will tend to decrease investment. Similarly, political scientists have found that many people are opposed to redistribution based on their values, preferences, beliefs, or political ideology (Feldman and Zaller 1992; Fong 2001; Gilens 1999; Petersen 2012; Petersen et al. 2012, 2013). General opposition could cause some participants to further discount any economic benefits of redistribution. This demotivation hypothesis holds that people focus primarily on the diminished rewards from redistribution. Thus, it predicts people will be *less* likely to make risky investments when they are subject to redistributive rules.

The third hypothesis, the *risk-pooling hypothesis*, comes from research in evolutionary anthropology about how humans manage uncertain income in small-scale foraging societies. In general, the literature on evolutionary political psychology holds that natural selection shaped our social psychology, and hence continues to influence people's political behavior in modern societies (Aarøe and Petersen 2013, 2014; Alford and Hibbing 2004; Hatemi and McDermott 2011; Loewen and Dawes 2012; Lopez and McDermott 2012; Fowler and Schreiber 2008; Petersen 2015). In particular, ethnographic research shows that small-scale societies exhibit rudimentary forms of redistribution of wealth. Namely, individuals share food and resources with those who have less, and food-sharing is governed by a variety of cultural rules and conventions, including rules that are enforced by the community rather than being voluntary (reviewed in Gurven 2004). Evolutionary researchers have argued that these social behaviors reflect an evolved risk-pooling psychology for managing uncertain income (Kaplan and Hill 1985; Kaplan et al. 2000; reviewed in Seabright 2004).

Many foragers face the problem of high variance in food supply. For example, ethnographic research on the Ache and Shiwiar in South American and the Efe in Africa shows that foragers frequently do not find food themselves whether due to bad luck, illness, or injury (Bailey 1991; Sugiyama 2004a, b; Sugiyama and Chacon 2000). In these difficult and uncertain environments, evolution can favor risk-pooling strategies because they benefit the individual by reducing variance in resources (Kaplan and Hill 1985; Kaplan et al. 2000, 2012; reviewed in Seabright 2004). For instance, in one study 65% of foragers would have died due to a disability had they not been part of a risk-pooling system (Sugiyama 2004a, b).

One key piece of evidence for risk-pooling in humans is ethnographic data showing that foragers are much more likely to share high-variance foods such as meat than low-variance foods such as tubers (Kaplan and Hill 1985; Kaplan et al.

2000). The important difference is that hunting is more dependent on chance whereas gathering tubers depends more on effort. The observation that foragers are more likely to share the luck-dependent resource provides evidence that they use sharing to buffer risk specifically, rather than other goals that are unrelated to resource variance like strengthening relationships. Moreover, the same pattern was observed in economic experiments with undergraduate students: Participants in a virtual foraging game were more likely to share high-variance than low-variance resources (Kaplan et al. 2012), providing evidence that risk-pooling is a basic feature of human social psychology (see also Kameda et al. 2002). Similarly, previous research using economic games found that people share income with unlucky group members (Büchner et al. 2007; Charness and Genicot 2009; Selten and Ockenfels 1998; Dawes et al. 2007; Trhal and Radermacher 2009). Importantly, these studies held constant the variance in income and overall economic efficiency. Thus, unlike the present studies, they were not designed specifically to test for risk-pooling or its effects on profitable investments.

Hence, there is a large literature showing how people's risk-pooling psychology affects sharing behavior. Importantly, and most relevant here, risk-pooling theory also makes a prediction about how people will approach risky opportunities when they can rely on sharing from others. To take advantage of risky opportunities, people would need to recognize whether they are under the protection of a risk-pooling scheme. Hence, risk-pooling theory predicts that people have the ability to recognize when a social safety net is available so they can take advantage of profitable but risky opportunities. This second prediction has not to our knowledge been tested in previous research. That is, whereas previous research examined how people share with those who suffer misfortunes, we focus on a critical complement to sharing behavior—whether people's investment decisions are sensitive to the presence of a social safety net. We note that this prediction converges with models from behavioral economics that assume risk aversion because they both predict greater investment when risk is pooled. Risk-pooling theory provides a psychological mechanism that explains *why* people's behavior might align with models of risk-averse choice, namely an evolved motive to subdivide gambles in order to reduce fluctuations in income.

In sum, the risk pooling hypothesis holds that people can recognize opportunities for risk pooling created by redistributive rules. Thus, it predicts that when rules for redistribution are in place, people will be more likely to take advantage of risky investment opportunities.

The Present Research

To test these hypotheses, we use experimental methods for studying economic and political institutions (Druckman et al. 2006; Dickson et al. 2015; Gerber and Green 2012; Loewen et al. 2014; McDermott 2002; Morton and Williams 2010; Ostrom 1998; Smith 1982, 2008; Woon 2012, 2014). In particular, we use an incentivized economic game to observe participants' investment decisions under different redistributive institutions. In this general approach (see especially Smith 1982), economic and political systems are defined as (a) a set of players whose choices

affect each other's payoffs, and (b) institutions that set the rules for how players interact and communicate. Following this conception, researchers use economic games with real payoffs and clear rules to create small-scale self-contained political systems for testing and falsifying political theories.

These micro-societies serve as model systems that are deliberately simplified compared to natural systems, similar to wind tunnels, test tubes, or fruit fly genomes in other sciences. The purpose of using model systems is not to make hasty generalizations to other real-world systems but rather to create repeated opportunities to falsify theories (Popper 1959). If an experiment fits the domain of a theory, even artificially, it can be used to hold the theory accountable. If a theory survives testing in a model system, then it should continue to be tested in new contexts.

We observe redistributive institutions in simplified micro-societies consisting of four citizens who make investment decisions under different redistributive institutions. Participants decide whether to keep their endowment of money or to make an investment with high-variance payoffs. Specifically, participants decide whether to invest cash in a risky venture that has a 25% chance of high gains (+350% profit) and a 75% chance of total losses (−100% loss), netting a positive expected value (+12.5% profit). This decision is analogous to investments of money, effort, or time in a job search, small business, education, or research when the expected rewards are positive but high-variance. Experiment 1 manipulates whether a redistributive institution requires participants to share all payoffs equally with other group members. Hence, the experimenter essentially plays the role of a government that imposes redistributive rules on participants.

Experiment 1

Methods

Risk-Pooling Game

We designed a risk-pooling game in which each player decides to *Keep* or *Invest* an endowment of money (Table 1). If a player chooses to invest, then they randomly receive one of four possible outcomes (each with a 25% chance). To model a low-probability windfall, we set the endowment to 40 (cents) and the four possible

Table 1 Experimental stimulus showing the four possible outcomes from investment

Number	Possible outcomes from investment	Percentage chance of getting this outcome	Mturk Bonus
1.	−40 cents	25%	40 − 40 = 0 cents
2.	−40 cents	25%	40 − 40 = 0 cents
3.	−40 cents	25%	40 − 40 = 0 cents
4.	+140 cents	25%	40 + 140 = 180 cents

investment payoffs are 0, 0, 0, and 180, respectively. Hence, investment has an expected value of 45, which reflects a +12.5% return on an initial investment of 40. In this situation, investment offers a substantial return on average but a player might be deterred by the 75% chance of losing all of their money, creating a potential risk problem.

Faced with this situation, a risk-neutral (or risk-seeking) player would always choose *Invest* but a risk-averse player might choose *Keep*, depending on the strength of their risk aversion. For example, one source of risk aversion is *loss aversion* in which the preference to avoid a loss is stronger than the preference to gain the same amount (Kahneman 2011). If a player weighs losses twice as much as gains, as found in some studies (Kahneman 2011), then the expected utility of *Invest* would be negative (−62.5%) and this loss averse individual would choose *Keep*.

Participants make their decisions in groups of 4 players. To study different types of redistributive rules, a researcher can vary whether and how players' earnings are redistributed after their investment payoffs are realized. Conceptually, it is possible for institutions to require participants to share earnings from keeping money, investing money, both, or neither. Each of these four circumstances presents players with distinct challenges including threats of loss, free-riding, and recklessness ("moral hazard," Arrow 1963). Experiment 1 examines the case in which earnings from both *Keep* and *Invest* are pooled compared to when no earnings are pooled.

Design and Hypotheses

In Experiment 1, we examine two cases in a between-subject design. In the individual condition, participants do not share any earnings. In the pooled condition, participants are required to share all earnings from both *Keep* and *Invest* decisions equally among the four group members. These two experimental conditions reflect opposite extremes, zero versus maximum redistribution of wealth.

The statistical confusion hypothesis predicts that participants will not recognize a difference between the individual and pooled conditions, showing no difference in investment. The demotivation hypothesis predicts that people are less willing to invest when they must share the rewards, so redistribution will decrease investment. The risk-pooling hypothesis predicts that participants will recognize a risk-pooling opportunity created by redistribution and hence will increase investment under a redistributive institution.

In order to recognize a novel risk-pooling opportunity, participants need to understand (consciously or unconsciously) that the pooled condition reduces variance in payoffs and decreases the probability of a loss. If everyone invests, then even if only one group member achieves the high return (180), then everyone earns more (45) than if everyone chose *Keep.* In this case, the probability of a loss is 32% compared to 75% without pooling. Therefore, a risk-averse player should find investment more attractive in the pooled condition than in the individual condition. The risk-pooling theory implies that people will intuitively understand these mathematical relationships and behave consistent with models of risk-averse choice, rather than responding to a redistributive institution mainly with confusion or demotivation.

Participants and Procedure

We recruited participants online using the Amazon Mechanical Turk website (Buhrmester et al. 2011; DeScioli and Kurzban 2009a; Horton et al. 2011). Online samples present a challenge that participants could be less focused or attentive than in a physical laboratory. Previous research shows that this issue can be overcome by administering comprehension tests and excluding participants with errors (Berinsky et al. 2014; Goodman et al. 2013; Horton et al. 2011; Oppenheimer et al. 2009). Participants who failed the comprehension test ($n = 41$) were excluded yielding a final sample of $n = 101$ (77% female, $M = 29.2$ years old). This exclusion rate is comparable to previous online studies using economic games and comprehension checks, which report failure rates of 25–50% (e.g., Horton et al. 2011). Participants earned 20 cents for completing the study ($\sim$5 min) and they could earn additional money depending on their decisions. After participants finished the study, additional earnings were calculated and paid to participants using the "bonus" feature on Mechanical Turk.

The task was presented online using Qualtrics survey software. Participants received a 40 cent endowment and decided whether to *Keep* or *Invest* the money. If they chose to *Invest*, then they received one of four outcomes determined by a random number generator. The four possible investment outcomes (-40, -40, -40, 140) and final payoffs (0, 0, 0, and 180 cents) were displayed to participants in Table 1. We chose this presentation based on research showing that people are better at understanding frequencies than probabilities (Cosmides and Tooby 1996; Gigerenzer and Hoffrage 1995).

In a between-subject design, participants were randomly assigned to either the individual condition or pooled condition. In the individual condition, participants read that their earnings depended only on their own decision and chance. In the pooled condition, participants read that all four group members' earnings would be divided equally among group members. The instructions emphasized the statistical independence of players' investments by stating: "Important: Each player's payment from Investment will be independently determined by using the random number generator separately for each player."

Next, participants completed three comprehension questions about the payoffs for different possible outcomes. Previous research shows that payoff comprehension questions are important for online studies using economic games (Horton et al. 2011). Then participants made their decision to *Keep* or *Invest*. After the decision, participants completed a post-experiment questionnaire. Two items assessed explicit judgments about redistribution of wealth. Participants indicated on a 7-point scale (*strongly disagree* to *strongly agree*) their agreement with two positive statements about redistribution: "More fortunate people should be required to share their wealth with less fortunate people," and "Taking money from people who have more money and redistributing it to people who have less money can increase economic productivity." These items were included to examine the effects of recent experience with redistribution on explicit judgments by testing whether participants' ratings differ across conditions. Finally, participants indicated their political ideology (liberal or conservative), income, sex, and age.

Results and Discussion

In the individual condition, 47% of participants chose to *Invest*, which did not differ from chance levels of 50%, $p = .78$, binomial test (Fig. 1).[1] The fact that participants did not significantly prefer investment shows risk aversion and hence that they faced a difficult risk problem. Despite expected returns of +12.5% for investment, roughly half of participants did not take advantage of this opportunity, presumably due to a fear of loss.

In the pooled condition, 68% of participants chose *Invest*, which was significantly greater than 50%, $p = .02$. Comparing across conditions, participants were more likely to invest in the pooled condition than in the individual condition, $p = .04$ (Fisher's exact test). This observation shows that participants who made decisions under an institution with maximum redistribution took greater advantage of a profitable investment opportunity.

To examine participants' explicit judgments about redistribution, we analyzed the percentage of participants who disagreed (rating <4) with each positive statement about redistribution (Table 2). We found nonsignificant effects of condition for both liberals and conservatives (Fisher's exact test, all $ps > .12$). That is, participants in the pooled condition had just experienced increased payoffs resulting from a redistributive institution, in which liberals and conservatives invested at similar rates (68% vs. 69%, respectively); nonetheless, these participants were not more likely to advocate redistribution. Participants' explicit judgments were shaped by their political ideology but not by their recent experience benefiting from a redistribution scheme.

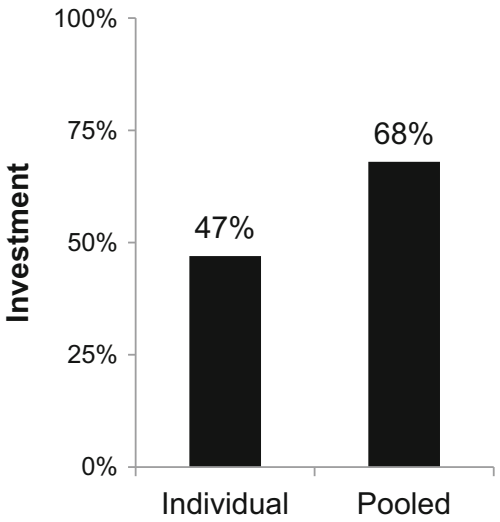

Fig. 1 Percentage of participants who chose *Invest* in Experiment 1

[1] The data for both experiments are available at: www.pdescioli.com/data/RiskPooling.zip.

Table 2 Percent who disagreed with positive statements about redistribution, Experiment 1

Statement	Individual		Pooled	
	Liberal (%)	Conservative (%)	Liberal (%)	Conservative (%)
"More fortunate people should be required to share their wealth with less fortunate people"	21	92	38	63
"Taking money from people who have more money and redistributing it to people who have less money can increase economic productivity"	15	75	18	63

Percent of participants in Experiment 1 who disagreed (rating < 4) with positive statements about redistribution in the individual condition (liberal: $n = 39$; conservative: $n = 12$) and the pooled condition (liberal: $n = 34$; conservative: $n = 16$)

In sum, although requiring individuals to share earnings could have reduced investment as predicted by the demotivation hypothesis, we found the opposite: Redistribution caused greater investment and increased economic efficiency. This observation supports the hypothesis that people have the psychological ability to recognize risk-pooling opportunities and to take advantage of the law of large numbers to reduce variance in payoffs (Kaplan and Hill 1985; Kaplan et al. 2000, 2012). The results are consistent with the risk-pooling model's prediction that people have an implicit understanding of how subdividing a gamble affects variance in payoffs. This is surprising in light of people's poor statistical understanding in other studies (Kahneman 2011). However, the finding is consistent with the idea that that people show better statistical knowledge for certain problems that they face repeatedly in everyday life or over evolutionary history (Cosmides and Tooby 1996; Gigerenzer and Hoffrage 1995). Thus in at least some contexts, a redistributive institution can increase economic efficiency.

Experiment 2

In Experiment 2, we address the issue of free-riding—a key factor that can potentially undermine the benefits of redistribution. Individuals who accept aid from other people but withhold aid when the tables are turned can gain a relative advantage and destabilize cooperation (Axelrod 1984; Hardin 1968; Olson 1965; Ostrom 1998; Trivers 1971). In order to sustain cooperation, individuals must be able to avoid free riders, and there is considerable evidence from psychological experiments that humans have cognitive mechanisms for detecting free riders (Cosmides et al. 2010; Delton et al. 2012). Particularly relevant here, Petersen (2012) found that people's cheater-detection systems also affect their public opinion about government redistribution by focusing their attention on whether welfare recipients are lazy or deserving of help.

In Experiment 2, we examine a risk-pooling institution that is vulnerable to free-riding and compare to an institution that prevents free-riding. Past research shows there are at least three different ways to prevent free riders from undermining

cooperation: Allow players to punish free riders, allow players to exclude free riders from receiving the benefits of cooperation, or allow players to assort themselves such that cooperators interact with other cooperators. In our experiment, we draw on the simplest of these and use an assortment mechanism (West et al. 2007).

Methods

Design

To investigate free-riding in the context of risk pooling, we use the same underlying risk problem as in Experiment 1 (Table 1) except with different rules for redistribution. In a between-subject design, participants are randomly assigned to either the pooled-investment condition or the matching condition.

The pooled-investment condition is designed to create a vulnerability to free-riding. Players are required to share earnings from their decisions to *Invest*, but they are not required to share earnings from their decisions to *Keep*. In this case, decisions to *Invest* increase the group's aggregate payoffs on average because the expected return is +12.5% and is divided equally. However, the money that individuals *Keep* is not shared but is private, which maximizes self-interest while diminishing aggregate payoffs to the group. Hence, this situation poses a type of social dilemma with a conflict between self-interest and group interest (Dawes 1980). Theories about free-riding predict that investment will be inhibited in the pooled-investment condition: People will recognize the vulnerability to being cheated so they will be more likely to *Keep* their endowment.

These theories also predict that investment could be revived by changing the rules of redistribution to prevent free-riding. One tempting solution is to privatize both the gains and losses from investment, but notice that this is the same as the individual condition from Experiment 1, which found that privatizing payoffs reduced economic efficiency compared to when risk was pooled.

We examine a different solution that is well known in the cooperation literature—assortment (West et al. 2007). In the matching condition, participants are matched with three other participants who make the same choice to *Keep* or *Invest*: Players who keep are matched with others who keep, and players who invest are matched with other investors. Due to matching, players who want to participate in a group investment with shared risk are no longer vulnerable to free-riding by other players who choose to keep the money. Without the threat of free-riding, a player's choice reveals their preference for collective risk-taking relative to the certain payoff from keeping their money.

The risk-pooling hypothesis combined with cheater-avoidance predicts that participants will be more likely to invest in the matching condition, when they cannot be cheated, than in the pooled-investment condition, when they could be cheated. Note that in both conditions, a player can guarantee themselves a minimum payoff of 40 by keeping their money, removing any element of risk. The key treatment difference is whether a player who chooses to invest is uncertain whether others will cheat (pooled-investment) or if they know the other players will also invest (matching condition).

If matching increases investment, this would show that it not only promotes cooperation (as found in previous research), but it can also help groups take advantage of risky investment opportunities by enabling risk-pooling.

Finally, we note a key difference between our matching mechanism and another matching mechanism used in previous experiments on cooperation (Gächter and Thöni 2005; Gunnthorsdottir et al. 2007). In these previous experiments, the experimenter matched participants based on their decisions in previous rounds of the game, rather than the current round. Thus, a cooperator could still be cheated, even if this was less likely, since matching was based on the past. In our matching mechanism, participants are matched based on their current decision, so it is not possible for a non-investor to free-ride on investors. This matching mechanism entirely removes the element of free-riding, making the participant's decision a choice between a certain payoff and a pooled gamble. In this case, the pooled gamble resembles a kind of *club good* in which only those who contribute can benefit from it (Delton et al. 2013; Ostrom 2003). This design allows us to examine participants' choices between a certain payoff and a pooled gamble when the institution makes investors vulnerable to free-riding (pooled-investment condition) or prevents free-riding (matching condition).

Participants and Procedure

We recruited participants on Amazon Mechanical Turk and used the same procedures as Experiment 1, except with different redistributive institutions. Participants who failed the comprehension test ($n = 27$) were excluded yielding a final sample of $n = 108$ (77% female, $M = 28$ years old).

As in Experiment 1, participants decided whether to *Keep* 40 or *Invest* and receive one of four payoffs (0, 0, 0, or 180; Table 1) determined by a random number generator. In the pooled-investment condition, participants read that earnings from *Invest* decisions are shared equally among all four group members. However, the money they choose to *Keep* is not shared with the group. In the matching condition, participants read that if they choose to *Invest*, then they will be matched with three other group members who choose to *Invest*, and all earnings will be divided equally among group members. If they choose to *Keep*, then they will be matched with three other group members who choose to *Keep*, and each individual will earn their own endowment of 40.

Results and Discussion

In the pooled-investment condition, 39% of participants chose to *Invest*, which did not differ from chance levels of 50%, $p = .14$, binomial test (Fig. 2). Moreover, this value did not differ from investment rates in the individual condition from Experiment 1 (47%), $p = .44$, Fisher's exact test. This shows that investment was inhibited by an institution that pools earnings from *Invest* decisions but not *Keep* decisions, consistent with the hypothesis that vulnerability to free-riding can undermine the benefits of redistribution. However, the threat of free-riding did not

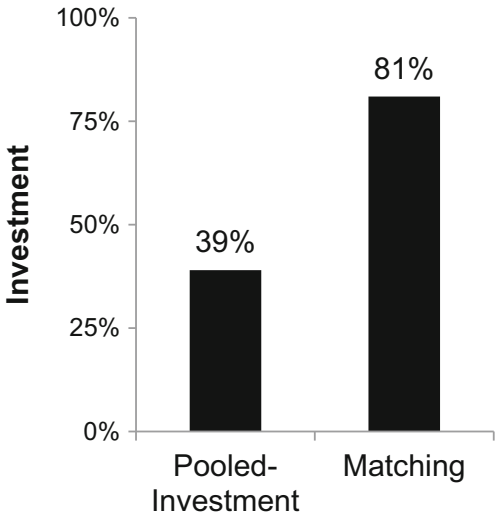

Fig. 2 Percentage of participants who chose *Invest* in Experiment 2

reduce investment to levels below the individual condition in Experiment 1 in which risk pooling was not possible.

In the matching condition, 81% of participants chose to *Invest*, which is greater than chance levels of 50%, $p < .001$. Comparing across conditions, participants were more likely to invest in the matching condition than the pooled-investment condition, $p < .001$, Fisher's exact test (Fig. 2). This finding shows that participants were more likely to pursue a risk-pooling strategy when there was no threat of free-riding. As a result, a solution to the cheater problem also supported a solution to the risk problem, allowing players to better capture low-probability gains and increase economic efficiency.

Notably, the results of the matching condition show that 81% of participants willingly entered into an institution requiring maximum redistribution of wealth, although they could have chosen *Keep* to avoid sharing wealth with other participants. (This differs from the pooled condition in Experiment 1 in which earnings from both *Keep* and *Invest* were shared.) This observation suggests that people's motivation to monopolize the profits from their own decisions was overcome by their motivation to pool risk and attain greater average payoffs.

To look at participants' judgments about redistribution, we analyzed the percentage of participants who disagreed (rating <4) with each statement about redistribution (Table 3). We found nonsignificant effects of condition for both liberals and conservatives (all ps $> .07$, Fisher's exact test). Similar to Experiment 1, participants' experiences in more and less successful redistributive institutions did not affect their explicit judgments about wealth redistribution.

In sum, we find that opportunities to free-ride can undermine a redistributive institution, and further that institutional solutions to free-riding can recapture the benefits of risk-pooling. In this experiment, we used an assortment institution to

Table 3 Percent who disagreed with positive statements about redistribution, Experiment 2

Statement	Pooled Investment		Matching	
	Liberal (%)	Conservative (%)	Liberal (%)	Conservative (%)
"More fortunate people should be required to share their wealth with less fortunate people"	23	76	45	74
"Taking money from people who have more money and redistributing it to people who have less money can increase economic productivity"	28	65	36	74

Percent of participants in Experiment 2 who disagreed (rating < 4) with positive statements about redistribution in the pooled-investment condition (liberal: $n = 39$; conservative: $n = 17$) and the matching condition (liberal: $n = 33$; conservative: $n = 19$)

prevent free-riding and stimulate investment. We suggest that similar performance might be observed for a variety of other solutions to free-riding including reciprocity, indirect reciprocity, reputation, punishment, and partner choice (Axelrod 1984; Ostrom 1990; Ostrom et al. 1992; Trivers 1971; West et al. 2007). Importantly, one strategy that prevents free-riding but fails to solve risk problems is privatizing payoffs. The individual condition in Experiment 1 shows that by preventing risk-pooling, privatization reduces profitable investments.

General Discussion

In two experiments, we find that redistributive institutions can increase investment and economic efficiency. In Experiment 1, participants who were required to share their earnings with the group were more likely to make profitable but risky investments, compared to participants who were not required to share. This improvement occurred under an extreme redistribution policy in which everyone earned the average—the equivalent of a 100% tax on income above the average. Even in this extreme form, redistribution did not decrease investment as the demotivation hypothesis predicts, instead showing the opposite pattern. Importantly, Experiment 2 found that the details of the institution are crucial: When participants were required to share earnings from *Invest* but not *Keep*, they were vulnerable to free-riding and reduced investment in response. Further, when this free-rider problem was solved by a matching institution, 81% of participants chose to *Invest* and enter a redistributive institution rather than *Keep* their endowment and remain independent.

Previous research found that government redistribution of wealth can generate long-term economic benefits including better health, less crime, and stronger governments (Stiglitz 2012; Wilkinson and Pickett 2009). The present experiments show that redistribution can additionally yield immediate gains in economic efficiency when people face risk problems. In this situation, redistribution can offer economic advantages by leveraging the law of large numbers to reduce risk. We find that people are able to recognize and take advantage of risk-pooling opportunities, rather than missing these opportunities due to statistical confusion, diminished

potential rewards, or ideological opposition to redistribution. However, to reap these benefits, the institution must prevent free-riding (Experiment 2), and further, must do so without privatizing payoffs because privatization undermines risk pooling (individual condition, Experiment 1). This observation suggests that redistribution can potentially increase or decrease efficiency depending on the payoff structure and the institution. This perspective focuses attention on understanding which redistributive institutions are most effective for which payoff structures.

Importantly, these experiments do not address whether government redistribution is good or bad public policy in general. Even these very simple experiments point to complex effects of redistribution that depend on local payoff structures and institutional details. Redistribution is likely to be even more complicated in natural environments. Different nations have a variety of redistributive institutions with different goals and different sets of rules for taxing earnings and targeting benefits. This cautions against broad generalizations and calls for textured theories about which redistributive institutions are beneficial or harmful in which economic environments.

The present results provide support for the theory that humans have psychological mechanisms for risk-pooling (Kaplan and Hill 1985; Kaplan et al. 2000, 2012). In Experiment 1, participants were able to recognize a risk-pooling opportunity in a one-shot interaction and a novel experimental task. Without previous experience, participants detected key variables, including the presence of group members and the requirement for sharing wealth, and adaptively changed their behavior in response. Critically, consistent with the risk-pooling model's predictions, participants showed an implicit understanding of how subdividing a gamble affects the variance in payoffs. Experiment 2 provides similar evidence for psychological abilities for risk-pooling combined with cheater detection (Cosmides et al. 2010). In an unfamiliar task, participants were able to identify vulnerabilities to free-riding in advance, and to adjust their investment strategies accordingly. Moreover, participants were able to weigh the threat of free-riding against the benefits of risk pooling, leading to a risk-pooling strategy that was contingent on the threat of free-riding.

We note that these psychological theories do not imply or require that people are consciously aware of the variables influencing their investment decisions. Many sophisticated psychological processes such as vision (Purves and Lotto 2003), language (Pinker 1994), and moral judgment (DeScioli and Kurzban 2009b, 2013; Haidt 2001, 2012) are entirely or partially inaccessible to conscious awareness. The data from participants' explicit judgments suggest a similar lack of awareness about redistribution. Participants who directly benefited from redistribution nonetheless disagreed with positive statements about it at the same rate as those without this experience. Explicit judgments were instead shaped by political ideology, with liberals positive and conservatives negative about redistribution. For instance, in the matching condition of Experiment 2, 74% of conservatives disagreed that redistribution can increase economic productivity, despite the fact that they themselves had just achieved greater productivity resulting from redistribution.

In fact, previous psychological theories specifically predict that risk-pooling strategies will be mostly non-conscious (Tooby and Cosmides 1996). Rather than conscious reasoning, people help those who suffer misfortunes based on altruistic

emotions such as empathy and compassion. These emotions function as commitment devices (Schelling 1960) by making people more likely to follow through with their good intentions to help when misfortunes occur (Frank 1988). This function of altruistic emotions is analogous to modern legal contracts that bind insurance companies to help customers in need, despite the company's incentive to defect. In contrast, help based on conscious calculation is less reliable and credible, like an insurance company's promise without a contract, because the cost/benefit ratio changes when a need for help occurs. Tooby and Cosmides (1996) argue that individuals who possess and display strong altruistic emotions gain an evolutionary advantage by attracting better social partners (Axelrod 1984; Trivers 1971; West, Griffin, and Gardner 2007) due to the credible social insurance they can provide.

Participants' explicit attitudes might also be shaped by ambivalence about redistribution caused by conflicting perceptions and values (Feldman and Zaller 1992; Fong 2001; Gilens 1999; Norton and Ariely 2011). If people have different perceptions of the variance in incomes, then risk-pooling theory predicts that they will disagree about whether individuals with low income should be helped. Further, psychological mechanisms for risk pooling could favor redistribution, while mechanisms for avoiding cheaters (Delton et al. 2012) or establishing individual property rights (DeScioli and Wilson 2011) could oppose redistribution. These different values might in turn be shaped by distinct psychological systems that evolved for small-scale interactions (Aarøe and Petersen 2013, 2014; Petersen 2012; Petersen et al. 2012, 2013). If so, different perceptions and evolved strategies provide a key source for ideological conflicts and divergence in public opinion about redistribution.

These studies use online samples which limits generalizations. Convenience samples such as online participants or undergraduates are valuable model systems for exposing theories to potential falsification. However, like wind tunnels or mouse immune systems, caution and additional study is required for generalizing from a model system to different contexts (and similarly, from one natural context to another). Model systems are designed to subject theories to falsification (Popper 1959) rather than to estimate population parameters (like polling or forecasting). For instance, the present studies indicate that ideology plays a role in attitudes toward redistribution; however, they are not designed to precisely quantify the differences between American liberals and conservatives, specifically, which would call for representative samples of these groups.

The risk-pooling game developed here can be used to further investigate institutional solutions to risk problems. The present experiments focus on capturing low-probability gains, whereas previous research on risk pooling focused on avoiding low-probability losses such as catastrophic floods or droughts (Aktipis et al. 2011; Fafchamps and Lund 2003; Kaplan et al. 2012). To examine low-probability losses, the risk-pooling game could be modified by setting the investment payoffs to 60, 60, 60, and 0, which has an expected return of +12.5% on an investment of 40. A second issue is partial redistribution. Rather than requiring participants to divide earnings equally, they could be required to share 50%, 25%, or another intermediate value. A third consideration is the timing and transparency of redistribution, such as whether participants know their own earnings

before or after redistribution levels are determined, varying the "veil of ignorance" (Rawls 1971). A fourth issue is the means by which resources are acquired and the role of skill, effort, and chance. These factors could evoke different psychological systems and hence affect the performance of institutions.

A final area for future work is the case in which earnings from *Keep* are shared but earnings from *Invest* are private. In this situation, both risk-pooling and cheater-avoidance favor profitable investment. Importantly, however, free-riding motives could also favor unprofitable investment, as long as the negative returns on a given dollar are not less than the share of a dollar they *Keep*. This circumstance creates a *moral hazard* (Arrow 1963) such as when fund managers share a portion of investment gains while clients bear all of the losses, an arrangement implicated in the 2008 U.S. financial crisis (Dowd 2009). To examine this issue, the payoffs of the risk-pooling game can be modified to present an unprofitable opportunity, such as an endowment of 40 and final investment payoffs of 0, 0, 0, and 140, which yields a negative expected return (−12.5%). In this situation, if earnings from *Keep* are shared but *Invest* are private, then self-interested players will invest, decreasing economic efficiency. In contrast, if income from both choices is shared, then the risk-pooling hypothesis predicts that players will not invest. Researchers can test an institution's ability not only to promote profitable investment but also to discriminate between profitable and unprofitable investments.

In closing, we hope these studies reinforce growing appreciation of experimental approaches to economic and political institutions. Theories about institutions necessarily rely on theories about human psychology and can be tested, refuted, and revised by empirical tests. Yet debates over redistribution are often based on introspection, political ideology, and deductive mathematics rather than experiments. For instance, economic models often assume actors have a single motive to maximize monetary payoffs but experiments demonstrate a variety of other motives including different types of altruism (DeScioli and Krishna 2013), punishment (Yamagishi 1986), revenge (Nowak et al. 2000), and risk pooling (Delton and Robertson 2012; Kaplan and Hill 1985; Kaplan et al. 2000, 2012). Moreover, human psychological systems are not only sources of irrationality but instead provide the basic psychological abilities that make humans "better than rational" at solving many problems (Cosmides and Tooby 1994). The present experiments suggest that the effects of redistribution depend on the precise balance of psychological systems evoked by the economic problem and the specific structure of the redistributive institution.

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