Poverty and Probability:

Aspiration and Aversion to Compound Lotteries in El Salvador and India

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Abstract

Some experimental participants are averse to compound lotteries: they prefer simple lotteries that depend on only one random event, even when the simple lotteries offer lower expected value. This paper proposes that many behavioral "investments" represent more compound risk for poorer people – who often face multiple dimensions of deprivation – than for richer people. As a result, identical aversion to compound lotteries can prevent investment among poorer people, but have no effect on richer people. The paper reports five studies: two initial studies that document that aversion to compound lotteries operates as an economic preference, two "laboratory experiments in the field" in El Salvador, and one internet survey experiment in India. Poorer Salvadoran women who choose a compound lottery are 27 percentage points more likely to have found formal employment than those who chose a simple lottery, but lottery choice is unrelated to employment for richer women. Poorer students at the national Salvadoran university choose more compound lotteries than richer students, on average, implying that aversion to compound lotteries screened out poorer aspirants but not richer ones. Poorer and lower-caste Indian participants who choose compound lotteries are more likely than those who choose simple lotteries to have a different occupation than their parents, which is not the case for better-off participants. These findings that the consequences of aversion to compound lotteries are different in the context of poverty and disadvantage are robust to regression respecifications and the inclusion of covariate controls, including for academic and math ability and demographic heterogeneity.

Keywords: poverty, reduction of compound lotteries, compound risk, employment, El Salvador, India, lab experiments in the field

JEL codes: O12, D80, D10, J20

"When you were poor, you had to have luck and do nearly everything absolutely right."

(LeBlanc, 2003)

1. Introduction

This quotation, from the sociological ethnography *Random Family*, describes the challenges faced by Coco, a young, unmarried mother who moves among housing projects and temporary jobs with little security or permanence. Coco's economic future was not merely uncertain, it compounded uncertainty upon uncertainty: she had to "do nearly everything absolutely right." A daughter's illness, an ex-boyfriend's return to cocaine, a late city bus, a delayed appointment with a social worker, an unexpected bill – any of these alone could disrupt any project to which Coco might aspire. Unlike richer people with more slack and more security, Coco needed each step to go her way: any aspiration was a compound lottery.

1.1 Reduction of compound lotteries

Projects with many random steps are "compound lotteries." A compound lottery is an objectively risky proposition contingent upon the intersection of multiple, sequential risky events; a simple lottery, in contrast, only depends on one. Therefore "you win a dollar if a coin toss comes up heads" is a simple lottery; "you win a dollar if a coin toss comes up heads and then a die rolls an even number" is a complex lottery. Naively, a compound lottery appears to require more steps to "go your way."

Objectively risky lotteries – unlike subjective uncertainty – come with explicit probabilities. This means that the overall probability of winning a compound lottery can be computed, and the lottery could be treated like a simple lottery with this overall probability of winning. For example "you win a dollar if a fair coin toss comes up heads both times" is a compound lottery that reduces to "you win a lottery with 25 percent probability." This equivalent treatment is known as the "reduction of compound lotteries," and the assumption that people reduce compound lotteries to their simple equivalents is embedded in expected utility theory's ordinary application.

Few experiments have studied reduction of compound lotteries explicitly. Ronen (1971) studied the effects of reducing compound lotteries – which he called "sequential aggregation" – on business decisions. He considered the case of building a transistor: "a successful assembling of a transistor is contingent upon a successful fabrication stage." In other words, two independent steps must succeed: fabricating the parts, and assembling them together. Ronen wanted to know how accountants should explain these situations to executives: "Our decision-maker wishes to know not only the cost, but also the probability of producing a good finished unit. Would it make a difference… if instead of giving him an overall estimate of 54 percent, we break this down and present to him the estimates of, say, 90 percent and 60 percent for fabrication and assembly?"

Ronen recruited graduate business students for an experiment. Ronen's participants did not have the option of choosing a simple lottery. Instead, they had to choose between two compound lotteries: all involving drawing a blue marble out of a first bag, and a red marble out of a second. The business students did not reduce the compound lotteries; instead they generally chose the strategy with the higher probability of winning the first round – sometimes even if it meant a lower probability of winning overall.

In a more recent experiment, Halevy (2007) finds that participants who are ambiguity neutral – that is, those who do not especially dislike gambles without explicit probabilities – are more likely to reduce compound lotteries. Many participants were compound lottery averse: they preferred simple lotteries. These results suggest that compound lottery aversion is an economic preference, conceptually comparable to risk aversion, ambiguity aversion, or social inequality aversion. However, no previous research that I am aware of has studied the consequences of this preference for economic outcomes.

1.2 Aspiring while poor as a compound lottery

The opening quotation suggests that life is a compound lottery for Coco. This paper proposes that investing in most projects – for example, going to school, finding a job – is a more compound lottery for poorer people. These investments, and the lives they may improve, are risky and uncertain for everybody, rich and poor. However, because poverty typically reflects multiple dimensions of disadvantage (Sen 1999, Deaton 2007), aspirations often require more steps to succeed for poorer people than they do for richer people. Poorer people may live further away, depend on public resources and transportation, speak different languages or in different accents, face social exclusion, have fewer family resources – and each of these may create another obstacle that must be (partially randomly) overcome, relative to richer people attempting the same project.

If so, Table 1 details an economic screening mechanism that could result. Some people reduce compound lotteries, while other people are averse to compound lotteries, and this is true both among the rich and among the poor. However, life is more like a compound lottery for the poor, especially when they consider whether or not to make an investment. Therefore, aversion to compound lotteries does not change richer people's outcomes because – whether they invest or not – they may face risk, but they do not face particularly compound risk. For poorer people, however, the exact same aversion to compound lotteries will prevent them from making an investment because that investment would be a compound lottery – one requiring finding the right bus to the city, it arriving on time, finding the next bus, arranging child care during all of this, feeling healthy, not being socially or racially excluded, getting to know people in town…

Hypothesis: *Aversion to compound lotteries prevents investment among poorer people by more than it does among richer people.*

To be clear, the hypothesis is not that poorer people are more averse to compound lotteries than richer people; rather, the hypothesis is that aversion to compound lotteries has a more discouraging effect on poorer people than it does on richer people, because investments in the context of poverty entail more two initial studies that document that aversion to compound lotteries is common and behaves like an economic preference, two studies in El Salvador find that aversion to compound lotteries screens poorer people out of finding employment and going to university respectively, without having a similar effect on richer people. A further study in India, a conservative society where caste and tradition shape many life choices, finds that choosing compound rather than simple lotteries is associated with having a different career than one's parents among poorer and lower caste participants, but not among richer and higher caste participants.

This is far from the first paper to take a lab experiment to participants in a developing country (Cardenas & Carpenter, 2008).[1] This paper differs from earlier lab experiments on

[1] Henrich, *et al*. (2010) offer a recent review of many such behavioral studies (although their purpose is to demonstrate that scope remains for many more). The papers most similar to this one shed light on poverty by demonstrating a correlation between experimental behavior and economic heterogeneity. For example, in experiments in Colombia, Cardenas (2003) finds that groups with participants that are more heterogeneous in real wealth are less able to manage common resources in the lab. Tanaka, *et al*. (2010) show that richer villagers in Vietnam behave more patiently and less risk aversely in lab experiments. In trust games with punishment, Hoff, et al. (2011) report that low caste people in rural India are less likely to punish violations of trust.

poverty in the field in that it proposes not simply a correlation between preferences and outcomes, but specifically an interaction among preferences and situation that influences economic outcomes. Importantly, because this paper's central hypothesis is an interaction, the vast range of unobservable heterogeneity that is correlated with poverty is not, itself, a threat to empirical identification, unless it also interacts with compound lottery preference. The key question asked here is whether aversion to compound lotteries has different effects for the poor than for the rich.

In contrast, what could be a threat to identification is another economic preference that is correlated with compound lottery aversion and specially interacts with poverty. For example, it could be the case that poverty not only entails more compound risk, but it also entails worse risk, in the sense of a lower probability of success at each stage. This may be true, and if so then ordinary risk aversion would also interact with poverty in decisions of whether to invest. If so, this would threaten this paper's identification only if risk aversion were correlated with compound lottery aversion as measured here. Study 5 explicitly measures risk aversion in additional games and finds no evidence that it is responsible for this paper's findings.

A more complicated case is the apparent close connection between compound lottery aversion and ambiguity aversion. Halevy's (2007) demonstration of a correlation across participants of aversion to compound lotteries and ambiguity aversion suggests that these phenomena are similar: perhaps ambiguity is mentally represented as compound risk, or *vice versa*. It is outside of the scope of this applied paper to attempt to settle the unresolved theoretical possibility that compound lottery aversion and ambiguity aversion are the same or deeply related preferences, explored by Segal (1987) and more recently by Seo (2009). It is perhaps reasonable to imagine that ambitious investments are *both* more complexly risky and more ambiguous for the poor than for the rich, especially if these are subjectively similar categories.

2. Study 1: Preferences and mistakes among U.S. undergraduates

This paper is predicated on the interpretation that choosing simple lotteries over complex lotteries is, at least in part, expressing a preference. In this interpretation, aversion to compound lotteries is conceptually comparable to risk aversion, uncertainty aversion, or impatience. If aversion to compound lotteries were merely a mistake – in the extreme, perhaps a simple arithmetic error – then lottery choice could reflect nothing more than academic or math ability. In this case, demonstrating that economic outcomes are correlated with lottery choice would simply be confirming the well-known importance of academic abilities.

Study 1 produced evidence that aversion to compound lotteries is not merely an arithmetic mistake. This study elicited lottery choices among Princeton University undergraduates. Being at a top-ranked university, these students had all presumably earned high standardized test scores by correctly answering questions harder than those in the experiment. The experiment found that just over half of the participants selected a simple lottery with a lower probability of winning than was offered by the complex lottery alternative. This was despite participants' knowing they would be paid more for winning the lottery, answering all probability test questions correctly, and being given an instruction sheet that numerically demonstrated the particular arithmetic involved in this choice.

2.1. Method

Forty-five undergraduate students were recruited using an online campus calendar and recruitment system (http://pless.princeton.edu). Each participant's session was conducted one-on-one with the experimenter, and took from 10 to 15 minutes. Participants received $5 for participating in the experiment and another $15 if they won the experimental game, for a total of either $5 or $20.

Table 2 summarizes the participants' options. The experimental game used three opaque, padded manila mailing envelopes and a set of one-inch square plastic tokens from a teaching supply store, some blue and some yellow. One envelope contained 2 blue and 3 yellow tokens and was marked "2 blue, 3 yellow;" the other two envelopes each contained 2 blue and 1 yellow token and were marked "2 blue, 1 yellow." Participants were told that they would play the game once and had two options about how to play the game (the order and labeling of the options was randomly counterbalanced across participants):

- **Option A**: Draw one token randomly from the "2 blue, 3 yellow" envelope without looking inside; you win if the token you randomly draw is blue and lose if the token is yellow.
- **Option B**: Draw two tokens, one from each of the "2 blue, 1 yellow" envelopes, without looking inside; you win if both of the tokes you randomly draw are blue, and lose if either token is yellow.

Option A (using these labels) is a simple lottery that offers a 40 percent chance of winning. Option B is a compound lottery that offers a 4/9 or approximately 44 percent chance of winning. Therefore, a participant who sought to maximize the chances of winning, irrespective of lottery type, would choose Option B.

After making the lottery decision between the two options but before determining whether the participant won, each participant completed a three-question probability test designed to assess whether the participant understood probability and compound lotteries. The three questions were:

1. $2/3 \times 2/3 =$ ______ .
2. If event A has a 2/3 probability of happening and event B has an independent 1/2 probability of happening, what is the probability that events A and B both happen?
3. Anita has to take two buses to get to the university on time. If the first bus has a 3/4 chance of arriving on time and the second has an independent 1/3 probability of arriving on time, what is the probability that they both arrive on time?

Question 1 is notable because it tests the exact computation required by the experimental game.

Half of the participants were randomly assigned to an experimental “debiasing” treatment. Immediately before making their lottery decision, they were handed a piece of paper and given the spoken instructions “you may use this piece of paper if you wish.” The paper contained two columns of arithmetic results: one of multiplied fractions, and another converting fractions to decimals. In particular, the paper stated clearly that $2/3 \times 2/3 = 4/9 \cong 0.44$ and $2/5 = 0.40$. Almost all participants given the paper spent at least some time reading it. Random assignment to this debiasing treatment or to a control group was done in advance with Microsoft Excel, and was stratified by gender.

This study was conducted at PLESS, the Princeton Laboratory for Experimental Social Science and was approved by Princeton University’s Institutional Review Board for Human Subjects and the PLESS manager.

2.2. Results and discussion

Overall, 23 of the participants (51 percent) chose the simple lottery, although it offered a lower probability of winning. In particular, 39 of the 45 students answered all three probability questions correctly, and of these 20 chose the simple lottery. As Figure 1 reveals, participants who received the debiasing treatment were slightly more likely to choose the simple lottery than participants in the control group, although none of these differences are statistically significant. This study suggests that, at least in some cases, choosing a simple lottery over a complex lottery with a higher expected value can be interpreted as a preference, rather than an arithmetic mistake.

3. Study 2: Aversion to compound lotteries among Salvadoran undergraduates

Study 2 builds on Study 1's lab experiment, among college students in El Salvador. Would these students also choose simple lotteries, even when compound lotteries offered higher expected value? Would lottery choice merely reflect observable differences in academic ability or performance?

3.1. Method

Participants. College student participants (36 women, 14 men; age range 18 to 24 years, median 19) were recruited in the fall of 2009 from among the Facultad de Economía (business school) of the Universidad de El Salvador, the country's only public university. Of the 50 students, 36 of them were born in San Salvador (the capital, largest and most commercially important city in El Salvador) and 30 reported that their father is or was a salaried employee. Participants signed up for 15 minute appointments after the experimenter made announcements in economics classes. Each participant's session was conducted one-on-one with the experimenter in Spanish, and took from 10 to 15 minutes.

Procedure. The experiment was conducted in four steps. First, each participant made four decisions, each between two lotteries, one simple and one compound. Then the participant completed two tests: a three-question test of simple probability math, similar to that used in Princeton, and a Spanish-language version of the Cognitive Reflection Test (CRT). The CRT tests whether participants give attractive but wrong answers (Frederick, 2005). The CAT's questions were slightly reworded using more familiar subjects: making *pupusas* instead of widgets, buying a pencil and notebook rather than buying a baseball and bat. Next the experimenter asked survey questions about the participant's economic and demographic background. Finally, one of the four decisions was randomly selected to be played for the participant's payment.

Table 2 again summarizes the options presented to the participants. The probability of winning with the simple lottery ranged from 25 to 90 percent, and the advantage of the compound lottery ranged from 0 to 11 percentage points, but was never negative. Mechanically, the experiment was conducted using the same blue and yellow tokens inside labeled, opaque, padded mailing envelopes. The participant sat in a chair facing a table upon which the four decisions were arrayed; the experimenter sat behind the table and conducted the interview orally. For example (translated into English):

"In this first game, like in the other games, there are two ways to play: Option A and Option B. You will tell me how you prefer to play each game.

"This is Option A: There are two envelopes, and each one contains 19 blue tokens and 1 yellow token. To win, you must draw a blue token from both envelopes.

"This is Option B: There is one envelope, which contains 9 blue tokens and 1 yellow token. To win, you must draw a blue token from this envelope.

"If you were going to play this game, would you prefer Option A or Option B?"

The question was asked conditionally because the participant knew that only one of the four decisions (referred to as "games" to the participant) would be selected to be played. Hey &

Lee (2005) demonstrate that, in experiments that use this common "random lottery incentive mechanism," participants separate decisions and treat them as unrelated choices, so experimenters need not worry about one game having a complex effect on another. The order of the four decisions and the assignment of option A and B were independently randomly counterbalanced across participants.

Participants were paid $3 for participating if they lost their game (El Salvador uses U.S. currency) or $6 for participating if they won their game. This was an exciting incentive that motivated participants to choose carefully. In San Salvador, a bus ride costs a quarter; for most of the students, their monthly college tuition was $4.80.

Ethical Review. This study was conducted at INVE, the Instituto de Investigaciones Económicas or Institute for Economic Research. Studies 2, 3, and 4 were approved by Princeton University's Institutional Review Board for Human Subjects, the Director of INVE, and the Universidad El Salvador's Facultad de Economía.

3.2. Results and discussion

The last column of Table 2 summarizes the students' choices. The participants often chose the simple lottery, although the compound lottery offered a higher chance of winning. Surprisingly, the advantage offered by the compound lottery is not monotonically related to lottery choice: participants were most likely to choose the compound lottery in the game when there was no incentive to do so. Only four percentage points more participants, a statistically insignificant difference (t = 0.36), chose the compound lottery when the advantage increased almost tenfold from 0.0025 to about 0.022.

While there was no clear effect of probability differences, there was a clear effect of probability magnitudes. The higher the probability of winning with the simple lottery, the less likely participants were to choose the compound lottery. A simple linear probability regression of an indicator for choosing the compound lottery on the probability of winning the simple lottery found that an additional ten percentage points of winning the simple lottery is associated with being 4.14 percentage points less likely to choose the compound lottery ($t_{50} = 2.95$, standard errors clustered by 50 participants).

Finally, like among the Princeton students, there was no consistent, monotonic relationship between academic or math performance and lottery choice. The 16 participants who answered no probability questions correctly selected 2.50 compound lotteries on average, while the 18 who answered one correctly selected only 2.44 compound lotteries, and the 16 who answered two or three questions correctly selected 2.88 compound lotteries; none of these differences are statistically significant. Eight of the 50 students answered one CRT question correctly; these selected slightly fewer compound lotteries on average than the rest of the students, who missed all three questions. Therefore, there is, again, no reason to interpret compound lottery choice as a marker of ability, rather than a preference.

4. Study 3: Employment among Salvadoran women

Studies 1 and 2 have preliminarily documented that some people will sacrifice expected value in order to play simple lotteries instead of compound lotteries, and that aversion to compound lotteries indeed appears to be a preference, rather than simply an indicator of intelligence or math ability. Studies 3 and 4 apply this understanding of aversion of compound lotteries to the main hypothesis of this paper: that aversion to compound lotteries will screen poorer people out of aspiration and investments, but will not have the same effect on richer people, because uncertainty is more complex for poorer people.

Study 3 tested this hypothesis by offering a choice between simple and compound lotteries to richer and poorer women in El Salvador. Finding a formal job is a complicated and uncertain process, especially for people who live outside of the central city. If finding a job represents a more compound lottery for the poorer women, then aversion to compound lotteries should be associated with lower employment only for this group, and not for the richer women.

4.1. Method

Participants. One-hundred Salvadoran women were recruited in unannounced, door-to-door visits. Fifty of these women (age range 18 to 55, median age 34) lived in Colonía Jardínes de Selsut, a largely concrete and cinder block peri-urban neighborhood located between lake Ilopango and the Pan-American Highway, about 45 minutes from San Salvador. Only 92 percent of this group had ever been to school; the median woman had 9 years of schooling; 44 percent were formally employed. The women from Selsut will be referred to as the *poorer* group in the statistical analysis.

The other fifty women (age range 18 to 60, median age 42.5) lived in San Salvador, and in particular in an upper middle class neighborhood between the national university and a major shopping center with malls and international chain restaurants. Every woman in this group had been to school, for 11 years at the median; 86 percent had formal employment. The women from San Salvador will be referred to as the *richer* group in the statistical analysis.

Procedure. All interviews were conducted at or outside participants' homes in Spanish on a Saturday or a Sunday. Half of the interviews were conducted by the author and half were conducted by a trained research assistant who did not know the author's hypotheses.

Participants were offered the same choice between a simple lottery and a compound lottery as the Princeton students: one envelope with a 2/5 chance of winning, or two envelopes, each with a 2/3 chance of a winning token. Like the students, they received $3 for participating if they lost the lottery they chose, and $6 if they won.

Each participant was also asked a set of survey questions. Whether the survey came before or after the game was randomly counterbalanced across participants. The key question was whether participants had a job. The term used – *empleo* – was clearly understood to mean formal employment, and participants were also asked about other, informal activity to make money. Participants were asked about their household size, whether they have children, whether they had been to school and if they knew “much,” “a little,” or “almost nothing” about math.

4.2. Results and discussion

The poorer participants were neither more nor less likely to choose the compound lotteries. Among the poorer group, 44 percent chose the compound lottery, compared with 54 percent among the richer group, a statistically insignificant difference ($p = 0.32$). This is not inconsistent with the hypothesis: recall that the point is not that poorer people are more likely to be averse to compound lotteries, but that this aversion is a greater deterrent for them, given their environment.

As the results in Figure 2 suggest, there is evidence for the hypothesized screening: among poorer women, choosing the compound lottery is associated with being more likely to have employment, but not among richer women. Among the 50 poorer women, those who chose the compound lottery were 27 percentage points more likely to report having a job (Fisher’s exact one-sided test: $p = 0.053$). However, this is not the best statistical test, for three reasons. First, the hypothesis concerns an interaction: screening should be *greater* for the poor. Second, it does not account for the possibility of omitted variable bias: despite the evidence from Studies 1 and 2, some readers may still be concerned that choosing the compound lottery is a marker for abilities that would be rewarded in the labor market. Finally, this linear treatment of probability ignores the 100 percent upper bound on possible employment for the rich.

To address these concerns, Table 3 presents results from 5 alternative specifications of the logistic[2] regression

$$\ln\left(\frac{employed_i}{1 - employed_i}\right) = \beta_0 + \beta_1 poor_i \times compound_i + \beta_2 poor_i + \beta_3 compound_i + \theta X_i,$$

where $employed_i$ is the probability that participant i is employed, *poor* and *compound* are indicators for being in the poor sample and choosing the compound lottery, respectively, and X_i is a vector of control variables, including having informal employment, education, and demographic variables. The hypothesis is confirmed in the positive coefficient estimated for β_1.[3] The fact that this coefficient changes little as more control variables are included moving from column 1 to column 3 – including self-reported math ability and schooling as a quadratic – suggests that the coefficient on the interaction indeed reflects a greater screening effect of aversion for compound lotteries for poorer participants than for richer participants.

5. Study 4: Screening among Salvadoran undergraduates

[2] Results and statistical significance are unchanged using OLS, which makes fewer assumptions but is less suitable for probabilities near 1.

[3] Because of migration, the estimate of this interaction would be a lower bound on the true effect. If migration between these sites is random, it will introduce noise into the geographic measure of poverty and attenuate the results. If migration is selective – such that people who invest and succeed move from the poor location to the rich location – then this would increase the concentration of those willing to invest in the rich pool at the expense of the poor pool, reducing the interaction. In fact, migration is unlikely to have had a quantitatively important impact on these results, but either way the true effect would be even *stronger*, if different at all, from that estimated here. I thank an anonymous reviewer for making this point.

Study 4 returns to the experimental data from the Salvadoran students in Study 2 and matches it to administrative data that the students authorized their university to release to the experimenter: their academic grades, and their monthly tuition payment. Admission at the Universidad de El Salvador is need-blind and based on an entrance exam, but tuition payments are an increasing function of the wealth of a student's family. In particular, 56 percent of the students in this sample and 60 percent of the student body pays the minimum quota: $4.80 per month. The rest pay an amount calculated according to a government formula, $20 monthly at the 75th percentile and $45 at the maximum in this sample. Therefore, paying the minimum tuition quota can be used as a proxy indicator of coming from a poorer family.

Study 3 compared richer and poorer participants to learn who invested in finding a job. Study 4 investigates a different prediction of the theory behind Table 1: only those who aspired and invested sufficiently to be at the college will be found among the students enrolled at the university. That is, only people in the three shaded blocks will be in the sample. Although richer students who are averse to compound lotteries will have made it to college because this aspiration did not represent such complex uncertainty to them, poorer students with the same aversion to compound lotteries will have been screened out of the student body, and therefore out of the data. This suggests a further test of the underlying hypothesis: among students now at the university, poorer students will be less averse to compound lotteries, on average.

5.1. Method

Study 4 is a further analysis of the data collected in study 2. With the permission of the students, the university anonymously matched the experimental data to the administrative data, using numerical codes. These matched data are used to estimate specifications of the linear regression

$$\begin{aligned} compound\ count_i \quad &= \quad \beta_0 + \beta_1 pays\ minimum_i + \beta_2 many\ siblings_i \\ &+ \quad \gamma_1 tuition_i + \gamma_2 GPA_i + \gamma_3 prob_i + \gamma_4 CRT_i + \gamma_5 female_i + \varepsilon_i, \end{aligned}$$

where *compound count*$_i$ is the number of compound lotteries participant *i* chose (out of four), and the γ variables are controls for the participants' tuition payment, GPA, probability test score, CRT score, and gender.

The key question is whether poorer students are more likely to choose compound lotteries than would be otherwise predicted given these control variables. For robustness, the regression uses two measures of poverty (or, scarce resources more generally): paying the minimum tuition quota, and having more than two siblings. Having more than two siblings is an indicator both of coming from a larger household (in El Salvador, these tend to be poorer, on average), and of having made it to the university despite potentially more intrahousehold competition for resources.

5.2. Results and discussion

As a manipulation check, a sample of 40 UES students unrelated to this experiment were asked whether they paid the minimum tuition quota and whether their household had each of a list of five assets: a radio, a TV, a refrigerator, a computer, and a car. On average, students who paid the minimum had about 0.86 fewer of these assets ($p = 0.013$), consistently with paying the minimum tuition being an indicator of relative poverty.

Table 4 presents the results of the linear regressions, with and without the covariates. As predicted, students who pay the minimum tuition choose about one more compound lottery, on average, and students with more than two siblings choose about one-half more compound lotteries, on average. These associations change little when covariates are added, which indicates that results are not likely to reflect unobserved heterogeneity in academic or other utility. This suggests that poorer people who were averse to compound lotteries never made it in the sample because they did not make it to the university.

While not directly related to the main hypothesis, the coefficients on the covariates suggest a more complicated story, in which poverty is unsurprisingly not the only factor associated with compound lottery choice. Students with higher grades choose more compound lotteries, on average, as do students who pay higher monthly tuition bills above the minimum quota. This suggests that, after passing the theorized compound lottery-poverty screen, among those who make it to the university socio-economic status buys ability and performance in the ordinary ways.

As a final check, the hypothesized mechanism was that poorer participants choose more compound lotteries, on average, because the set of poorer students who made it to the UES is missing the most compound-lottery-averse people. That is to say, as in Table 1, the groups of poorer and richer students should behave similarly among those who are not averse to compound lotteries, but the group of poor students should be missing those who are averse to compound lotteries. So, the samples of richer and poorer students should differ not merely on average, but specifically among those averse to compound lotteries.

This extra implication can be tested with quantile regression. Is the difference between the rich and poor samples concentrated among those who choose few compound lotteries or those who choose many? A simple quantile regression of the number of compound lotteries chosen on the indicator for paying the minimum tuition finds that the poorer students choose 0.48 and 0.40 more compound lotteries than richer students at the 5^{th} and 10^{th} percentiles of the count of compound lotteries chosen ($p = 0.041$ and $p = 0.016$, respectively), but no more compound lotteries at the 95th percentile ($\hat{\beta} = 0$; $p = 1$). As predicted, the screening occurred at the bottom of the distribution of poorer potential students.

6. Study 5: Intergenerational mobility, caste, and wealth in India

Studies 3 and 4 have provided evidence of a special screening role of compound lotteries in the lives of the poor. However, these studies have three limitations. First, they offered relatively small samples, constraining the sophistication of available double-checks of the conclusions. Second, poverty was – of course – not randomly assigned; the most convincing demonstration of its effect would therefore require controls for potentially omitted demographic variables. Third, they did not include measures of other preferences over risky choice, to verify that the result is not spuriously driven by differences in risk aversion or probability weighting.[4]

This study addresses each limitation, and expands the range of evidence to another developing-country context. 558 participants living in India were recruited on Amazon Mechanical Turk, an internet labor market. Experimental economists have a long tradition of computerized tasks. Although Mechanical Turk was originally designed to "crowdsource" divisible tasks, decision researchers are increasingly using it as a platform for research. Paolacci, *et al*. (2010) and Buhrmester, *et al*. (2011) both provide evidence that "MTurk" produces high-quality experimental data that replicate well-documented lab findings.

[4] If participants discount probabilities by some weighting fraction mapping from objective to subjective probabilities such as Prospect Theory's, then even if a compound lottery is objectively more likely to be won than a simple lottery, the weighted probability of winning the simple lottery could be greater than the product of the weighted probabilities of winning each step in the compound lottery, depending on the shape of the weighting function. This would not represent an aversion to compound risk.

After giving informed consent to participate, participants completed two sets of tasks. The first was a set of four experimental games: two offering a choice between a compound and a simple lottery, one eliciting risk aversion with a set of graduated questions, and one assessing non-linear probability weighting. Then participants completed a long set of survey questions. Included among these – with no special indication of its significance – was the dependent variable: whether participants have a different job, occupation, or career than their parents. In Indian society, which is still in many ways socially conservative and guided by caste norms (Deshpande, 2011), this could indicate a high level of aspiration or commitment to one's future.

6.1 Method

Participants. Participants were paid $0.21 through MTurk for completing the 5 to 10 minute experiment. This would represent about 10-15 percent of the spot wage of a day laborer (although even poor participants were clearly not that poor), or the price of a short ride on the Delhi metro. The MTurk software was set to only allow participants in India, detectable by IP address. Of the 558 participants, 67 percent were male; 40.7 percent were aged 19-24, 42.0 percent were aged 25-34, and the rest were older.

In order to complete the experiment, participants had to understand English. As recommended by Oppenheimer, *et al* (2009) for internet decision research, the survey included three "instructional manipulation checks" – questions with objective correct answers, such as a participant's count of fatal heart attacks – to screen out participants who did not understand the experiment or were not paying attention. The 558 participants were those out of a population of 847 who passed these tests; any remaining inattention would attenuate results towards zero. More detail is available in the supplementary material; regression results below re-computed with all 847 participants are qualitatively similar and retain statistical significance, but have predictably attenuated coefficient estimates.

Because this experiment required internet access and English comprehension, participants are clearly not representative of the Indian population. 89 percent report growing up in a house with a TV, 73 percent in a house with a refrigerator. The median participant has an undergraduate degree. 37 percent reported belonging to a low-ranking caste group. 78 percent reported a career that differed from their parents.

Procedure: Games. The experiment started with four risky choice games, in a randomly counterbalanced order. Participants were told that some participants would be randomly selected to have one of their game choices implemented for a monetary payment (an average of 500 rupees or about $10), to be paid over MTurk. The exact text of the four games is available in the supplementary material. The four games were:

- **Compound Lottery 1.** This is the same game played by the Princeton students and the Salvadoran women: a choice between two sub-lotteries with 2/3 probability, or one simple lottery with 2/5 probability.
- **Compound Lottery 2.** Participants chose between two sub-lotteries, each with 0.5 probability, or one simple lottery with 0.24 probability. Rather than using winning and losing tokens, these lotteries were implemented as the result of a computer choosing a random number uniformly from 1 to 100.
- **Risk aversion.** Participants made 10 binary decisions, each between winning 500 rupees for sure or a 0.5 chance of receiving another amount and a 0.5 chance of receiving nothing. The alternative prizes ranged from 500 rupees to 2000 rupees and were presented in increasing order.
- **Probability weighting.** Participants completed the same probability weighting task used in Harrison, *et al* (2009) and Humphrey and Verschoor (2004) in India and other

developing countries. Each participant made three binary choices among lotteries that assigned different probabilities to three payoffs (0, 500, and 1000 rupees). Each pair of lotteries was generated from another by shifting probability mass from one outcome to another, such that a participant who chose in accordance with independence of irrelevant alternative would make the same decision in all three pairs (the common consequence effect), but participants who weight probabilities non-linearly might reverse their choices.

Procedure: Survey questions. After completing all four games, participants completed a set of survey questions, including the dependent variable “Do you have the same job, occupation or profession as one of your parents?” with options “Yes, I have the same job, occupation or profession as one or both of my parents” and “No, neither of my parents had the same job, occupation or profession as I have.”[5] Additional demographic questions included categorizations of sex, age, educational achievement, size of hometown (large metro, large city, small city, town, rural), and religion and caste categories.

Participants’ socio-economic disadvantage was measured in two complementary ways: an asset index, and by caste. It is standard in econometric analysis of developing countries to use asset ownership as a proxy for wealth when expenditure data is unavailable (Filmer and Pritchett 2001). The survey asked “in the home where you lived as a child, did anybody ever own” each of ten items: a telephone, a TV, a bicycle, a scooter or motorcycle, a car, a pressure cooker, a refrigerator, an air cooler, an air conditioner, and a computer. Participants were classified as

[5] 28 percent of the participants were still students at the time of the survey, presumably in university or graduate school. However, in India college students are not as free to change majors as in the U.S., and many would already have a fixed occupational category. In any event, the regression results below are very similar, almost numerically identical, if the sample is restricted to non-students.

from an “asset poor” household if they had six or fewer of these, which was the median of this coarse variable, indicating 44 percent of participants.

Finally, participants’ caste membership was measured by asking participants to rate their family’s similarity on a scale from 0 to 100 with eleven social groups in India, including, for example, “middle class,” “poor,” “urban,” “rural.” A “low caste” score was constructed by adding participants’ similarity to “scheduled caste/Dalit” (sometimes called “untouchable”) and “Other Backwards Caste” families and subtracting their similarity to “forward caste” and “Brahmin” families. Participants were classified as low caste if this score was positive, which was 32 percent of participants.

6.2 Results

As Table 2 reports, participants here – as in the other studies – sometimes chose a simple lottery at a sacrifice of expected value, although at a lower rate than in the other studies. Compound lottery choice was uncorrelated with risk attitudes: in the risk aversion questions, the 12 percent of participants who chose the simple lottery in both cases chose the certain 500 rupees only 0.04 times fewer, on average, than the rest of the participants (t = -0.09), out of 10 opportunities and a mean of 6.75 times. Similarly, about 45 percent of participants showed no evidence of probability weighting (choosing in accordance with independence of irrelevant alternatives), whether or not they chose the simple lotteries (difference = -0.01; t = -0.01). What matters for the key hypothesis of this paper is whether there is evidence of screening by poverty: were participants from more disadvantaged backgrounds less likely to have a different occupation than their parents if they chose the simple lottery, relative to the effect on participants from more advantaged backgrounds?

As in study 3, answering this question requires testing for an interaction, here using the linear probability model:

$$different\ job_i = \beta_0 + \beta_1 poor_i + \beta_2 chose\ simple_i + \beta_3 simple_i \times poor_i + P_i\Gamma + X_i\theta + \varepsilon_i.$$

Is $\beta_3 < 0$? If so, this would indicate that aversion to compound lotteries is more discouraging for poorer participants than for richer participants. *P* is a vector of preference indictors, representing risk preference and probability weighting. Both are entered in two ways in different regressions:

- *parametrically*: the minimum risky amount better than a certain 500 rupees, and an indicator for choosing the same way from all three probability weighting pairs, respectively, and
- *non-parametrically*: a set of 10 dummies, one for each risky question, and a set of 8 dummies, one for each possible combination of answers to the three probability weighting questions.

X is a vector of 28 demographic controls for sex, seven age indicators, five city size indicators, six education indicators, an indicator for currently being a student, and eight religious group indicators. These covariates may additionally account for some of the unobserved heterogeneity across participants in the probability of risky investments in untraditional careers succeeding.

Table 5 provides evidence from a range of statistical specifications, including some with controls *P* and *X*. In every case – with either measure of compound lottery aversion, with either measure of disadvantage, with and without controls – the interaction is negative and statistically significant. Additionally, poorer participants are more likely overall than richer participants to have a different job than their parents.[6] This is an unsurprising validation of the data in this selected sample that understands English and uses the internet. The wide range of controls for preferences and demographic characteristics strengthens the screening interpretation of this association between intergenerational mobility and aversion to compound lotteries for the poor.

7. Summary and concluding discussion

Richer people and poorer people – to say nothing of top-ranked undergraduates – sometimes choose simple lotteries instead of compound lotteries that offer more expected money. This is true even among people who certainly understand that they are trading probability of winning for fewer events having to go their way, that is, for simpler uncertainty.

Poorer people face compound disadvantage, and often require more steps to go right for an aspiration to come to fruition. This means that if a richer and a poorer person have the same aversion to compound lotteries, the poorer person is more likely to be screened out of making an investment. The evidence in this paper is consistent with this hypothesis of differential screening: unlike richer women, poorer women who choose a simpler lottery are less likely to have found a job; among students who made it to a university, poorer ones (who overcame compound uncertainty) are more likely to choose compound lotteries. Importantly, while they use experimental data, Studies 3 and 4 are ultimately cross-sectional correlations of individual differences. However, Studies 1 and 2 suggest that mathematical ability is unlikely to be an important confounding omitted variable, and in Study 4 the result persists despite multiple controls for academic ability and performance, and in Study 5 despite controls for academic achievement, other risk preferences, and many demographic properties.

[6] It is also the case that choosing the simple lottery is positively associated with having a different job than one's parents among richer participants, although the theory makes no prediction about this. This could be a spurious result of having, by this stage in the paper, estimated many regressions.

Could the results of these studies be due to a similar mechanism that is not screening: that poorer people who for whatever reason succeed must learn not to be averse to compound lotteries? If so, it would still be interesting, as a case of poverty causing heterogeneity in economic preferences (Spears, 2011). For example, Voors, *et al*. (2010) argue that exposure to conflict and violence in Burundi makes participants more risk-seeking. However, accumulated experience or learning are unlikely to explain this paper's results. In studies 3 and 5, there is no general association between poverty and aversion to compound lotteries. Moreover, if experience were the mechanism, we might expect poorer people to become more comfortable with compound risk as they age and gain more exposure to it, but there is no evidence for this in the data, as there is no monotonic relationship. Also, we would expect a triple interaction: for the same reason, the interaction between poverty and lottery choice should be most apparent among older people. Again, the data offer little support for this, and no monotonic association with age. More detail about this analysis is available in the online supplementary appendix.

These results add to development economists' lists of possible poverty traps: mechanisms by which inequality and poverty can perpetuate themselves and deepen (Bowles, Durlauf, & Hoff, 2006). The same behavior – in this case, aversion to compound lotteries – will keep poor people from taking advantage of opportunities that it will not withhold from the rich (*cf.* Bertrand, Mullainathan, & Shafir, 2004). Massey & Sampson (2009) have lamented the "decided chilling effect" of appearing to blame the victim that has sometimes discouraged research on the behavior of poor people; perhaps recognizing that widely shared tendencies (such as aversion to compound lotteries) interact with the context of poverty offers a way through this barrier.

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Table 1

Theory: Compound lottery aversion screens out poorer people

	Poorer	richer
reduces compound lotteries	invests	invests
compound lottery averse	does not invest	invests

Table 2

Decisions between simple and compound lotteries

Simple lottery	p^s	Compound lottery	p^c	$p^c - p^s$	Simple (%)
Study 1: U.S. students (*n = 45*)					
2 win, 3 lose	0.40	2 win, 1 lose, 2×	0.44	0.04	51
Studies 2 & 4: Salvadoran students (*n = 50*)					
3 win, 9 lose	0.25	5 win, 5 lose, 2×	0.25	0	18
1 win, 2 lose	0.33	2 win, 1 lose, 2×	0.44	0.11	26
4 win, 6 lose	0.40	6 win, 2 lose, 3×	0.42	0.02	46
9 win, 1 lose	0.90	19 win, 1 lose, 2×	0.9025	0.0025	50
Study 3: Salvadoran women (*n* = 100)					
2 win, 3 lose	0.40	2 win, 1 lose, 2×	0.44	0.04	51
Study 5: Indian MTurk workers (*n* = 558)					
2 win, 3 lose	0.40	2 win, 1 lose, 2×	0.44	0.04	22
number 77-100	0.24	number 50-100, 2×	0.25	0.01	35

Note. "*x* win, *y* lose" indicates that an envelope contains *x* winning and *y* losing tokens; *n*× indicates that to win a compound lottery the participant must draw a winning token with replacement *n* times. p^s is the probability of winning the simple lottery; p^c is the unconditional probability of winning the compound lottery. Simple (%) is the percent of participants who chose the simple lottery.

Table 3

Log odds of employment by poverty and lottery choice among Salvadoran women

	(1)	(2)	(3)
poor × compound	2.953*	2.936*	2.791*
	(1.276)	(1.329)	(1.311)
poor	-3.838***	-3.663**	-3.791**
	(1.105)	(1.250)	(1.202)
compound	-1.838	-1.687	-1.358
	(1.128)	(1.059)	(1.064)
informal work			-1.965**
			(0.744)
age, age²		✓	✓
math indicators		✓	✓
schooling, schooling²		✓	✓
houshold size		✓	✓
has children		✓	✓
constant	3.091**	-2.259	-0.725
	(1.028)	(3.823)	(4.623)
pseudo R^2	0.21	0.28	0.36

Note. $n = 100$. Logistic regression coefficients with heteroskedasticity-robust standard errors in parentheses. *Poor* is an indicator for living in Selsut; *compound* is an indicator for choosing the compound lottery.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Table 4

Screening among the poor: Compound lottery choice, Salvadoran students

	(1)	(2)	(3)	(4)	(5)
pays minimum	1.030*	0.939*			0.925*
	(0.399)	(0.448)			(0.414)
many siblings			0.476*	0.468*	0.457*
			(0.209)	(0.201)	(0.188)
tuition	0.0469*	0.0492*		0.0156	0.0514**
	(0.0175)	(0.0184)		(0.00811)	(0.0176)
GPA		0.289*		0.295*	0.285*
		(0.124)		(0.116)	(0.116)
any probability		0.192		0.224	0.174
		(0.255)		(0.253)	(0.249)
CRT		-0.540		-0.572*	-0.498
		(0.316		(0.281)	(0.303)
female		0.144		0.0912	0.189
		(0.200)		(0.209)	(0.199)
constant	1.423**	-0.611	2.457***	0.186	-0.767
	(0.447)	(0.987)	(0.145)	(0.780)	(0.912)
R^2	0.130	0.298	0.074	0.271	0.364

Note. $n = 50$. Dependent variable is count of compound lotteries chosen, out of four. OLS regression coefficients with heteroskedasticity-robust standard errors in parentheses. *Pays minimum* is an indicator for paying the minimum tuition quota (60 percent of students); *many siblings* is an indicator for having more than two siblings.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Table 5

Intergenerational mobility and compound lottery choice, Indian respondents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
compound lottery:	2/3 × 2/3	2/3 × 2/3	2/3 × 2/3	2/3 × 2/3	1/2 × 1/2	2/3 × 2/3	2/3 × 2/3
poverty indicator:	low assets	low assets	low assets	low assets	low assets	low caste	low caste
poor × simple	-0.210**	-0.197**	-0.207**	-0.196**	-0.114+	-0.146*	-0.142+
	(0.0694)	(0.0700)	(0.0695)	(0.0697)	(0.0612)	(0.0739)	(0.0747)
chose simple	0.134**	0.0882+	0.133**	0.123*	0.117**	0.0885*	0.0813+
	(0.0465)	(0.0484)	(0.0466)	(0.0488)	(0.0448)	(0.0430)	(0.0441)
poor	0.160***	0.121***	0.157***	0.149***	0.140***	0.120***	0.107**
	(0.0337)	(0.0329)	(0.0334)	(0.0346)	(0.0384)	(0.0338)	(0.0345)
risk aversion		non-parametric	0.0000103	0.00000603	0.00000777	0.0000133	0.00000720
			(0.0000223)	(0.0000235)	(0.0000234)	(0.0000225)	(0.0000235)
probability not weighted		non-parametric	-0.0586+	-0.0581+	-0.0521	-0.0661*	-0.0612+
			(0.0318)	(0.0331)	(0.0335)	(0.0322)	(0.0333)
controls				✓	✓		✓
n	558	558	558	558	558	558	558

Note. The dependent variable is reporting having a different job than one's parents. OLS linear probability regression coefficients reported with heteroskedasticity-robust standard errors in parentheses. The parameterized risk aversion indicator is the lowest risky prize that the respondent prefers to 500 rupees for sure; the parameterized probability weighting indicator is an indicator for not exhibiting probability weighting. These are entered non-parametrically as sets of indicators for all possible responses. Demographic controls are sex, 7 age indicators, 5 city size indicators, 6 education indicators, an indicator for currently being a student, and 8 religious group indicators.

Two-sided p-values: + $p < 0.1$. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

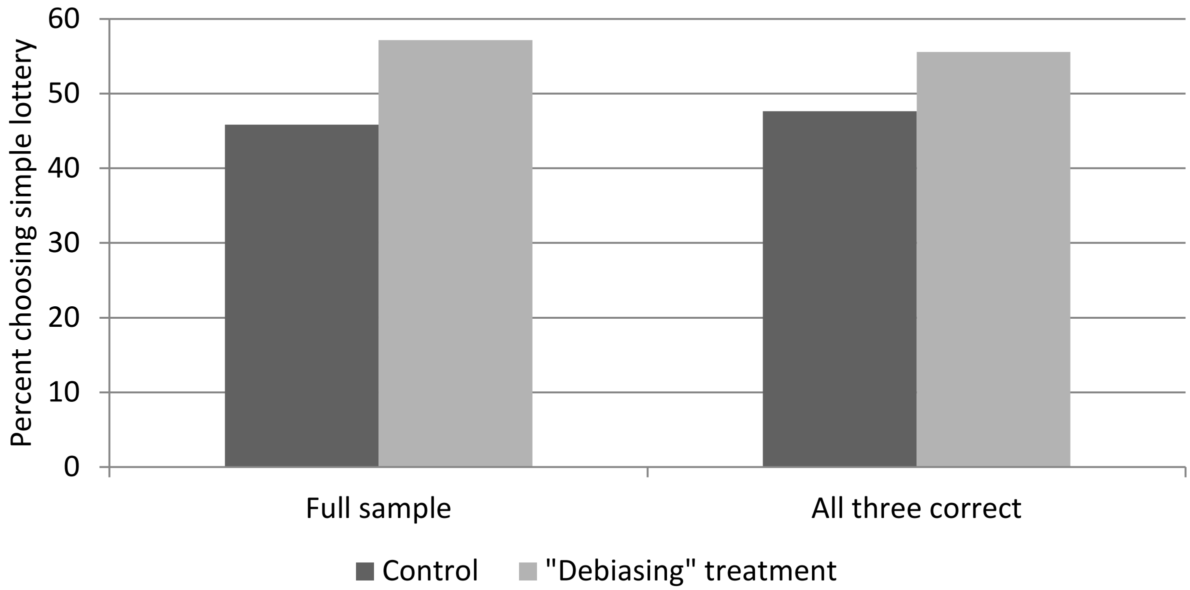

Figure 1. Percent choosing simple lottery, rather than compound lottery, among U.S. students. *n* = 45; "All three correct" restricts analysis to the *n* = 39 students who answered all three compound lottery math questions correctly. No statistically significant differences.

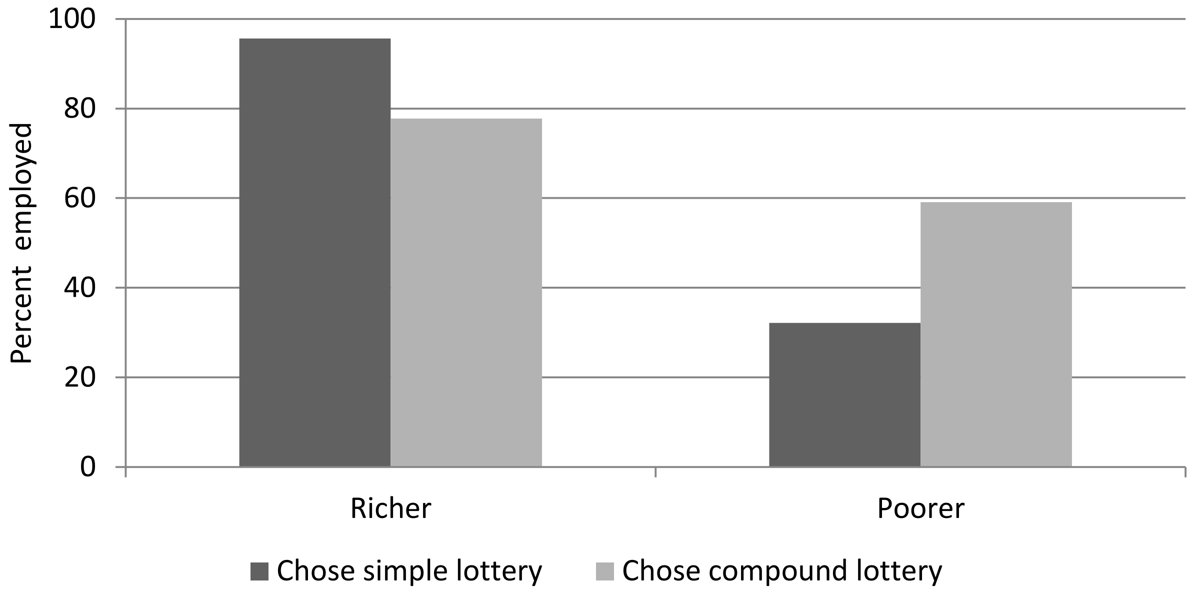

Figure 2. Percent employed, by lottery choice, among Salvadoran women. *n* = 100.