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Social preferences of future physicians

Jing Li[a], William H. Dow[b,1], and Shachar Kariv[c,1,2]

[a]Department of Healthcare Policy and Research, Weill Cornell Medical College, New York, NY 10065; [b]School of Public Health, University of California, Berkeley, CA 94720; and [c]Department of Economics, University of California, Berkeley, CA 94720

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We measure the social preferences of a sample of US medical students and compare their preferences with those of the general population sampled in the American Life Panel (ALP). We also compare the medical students with a subsample of highly educated, wealthy ALP subjects as well as elite law school students and undergraduate students. We further associate the heterogeneity in social preferences within medical students to the tier ranking of their medical schools and their expected specialty choice. Our experimental design allows us to rigorously distinguish altruism from preferences regarding equality–efficiency tradeoffs and accurately measure both at the individual level rather than pooling data or assuming homogeneity across subjects. This is particularly informative, because the subjects in our sample display widely heterogeneous social preferences in terms of both their altruism and equality–efficiency tradeoffs. We find that medical students are substantially less altruistic and more efficiency focused than the average American. Furthermore, medical students attending the top-ranked medical schools are less altruistic than those attending lower-ranked schools. We further show that the social preferences of those attending top-ranked medical schools are statistically indistinguishable from the preferences of a sample of elite law school students. The key limitation of this study is that our experimental measures of social preferences have not yet been externally validated against actual physician practice behaviors. Pending this future research, we probed the predictive validity of our experimental measures of social preferences by showing that the medical students choosing higher-paying medical specialties are less altruistic than those choosing lower-paying specialties.

social preferences | altruism | fair-mindedness | equality–efficiency tradeoff | rationality

> The behavior expected of sellers of medical care is different from that of business men in general. . . His behavior is supposed to be governed by a concern for the customer's welfare which would not be expected of a salesman (1).
>
> Medicine is one of the few spheres of human activity in which the purposes are unambiguously altruistic (2).

Social preferences are important inputs into broader measures of social welfare and enter many realms of decision-making. Obvious examples include cooperation (3, 4), redistribution (5, 6), and public goods generation (7, 8), which in turn, shape fundamental societal structures ranging from local commons to globalization among others. In all of these settings, problems of cooperation and conflict arise in connection with the distribution of resources under conditions of scarcity. These problems arise not only because people promote their competing private interests but also, because people who are motivated by morality to promote the interests of others will often disagree about what morality requires either in general or in particular situations (9–11).

Within academic discourse, the theoretical and empirical analyses of social preferences, therefore, have implications in a host of areas, which cut across disciplines ranging from economics through philosophy to law and more. In the policy arena, appropriately confronting theories of social preferences with empirical or experimental evidence has implications for public policy decisions, which often hover uncertainly between interest competition and moral disagreement. Economics, both in its theoretical apparatus and in its experimental methods, has successfully advanced understanding of the effects that social preferences—specifically through their heterogeneity—have on conflict and cooperation in conditions of scarcity.* Properly understanding these social preferences will require additional study of heterogeneity in behavior across individuals.

Social preferences are especially salient in health care, which is marked by resource scarcity (20), produces public goods with broad impacts on society's wellbeing, and at the same time, is fraught with information asymmetry and competing interests among providers, patients, and payers of care (1). In this paper, we study the social preferences of US medical students, a group that holds particular interest, because physicians are central to resource allocation in and quality of health care in a society. In their treatment decisions as well as decisions to adopt new scientific/medical technologies, physicians make fundamental tradeoffs between their own (financial) self-interest, patient benefit, and stewardship of social resources. In all of these cases, understanding physicians' choices requires understanding the social preferences that are behind them. Furthermore , studying medical students (as opposed to practicing physicians) allows us to examine the "baseline" social preferences of medical professionals before their exposure to complex incentives in the environment in which physicians practice, as these incentives may shape social preferences in ways that make directions of causality difficult to disentangle.

This topic is particularly relevant at present: health insurers and governments in the United States and elsewhere have

Significance

This paper advances scientific understanding of social preference—a topic of longstanding cross-disciplinary interest—by studying the preferences of future physicians. In making treatment decisions, physicians make fundamental tradeoffs between their own (financial) self-interest, patient benefit, and stewardship of social resources. These tradeoffs affect patient health, adoption of new scientific medical technologies, and the equity and efficiency of our health care system. Understanding physicians' decisions about these tradeoffs requires understanding the social preferences that are behind them. Our main finding that future physicians are substantially less altruistic and more efficiency focused than the average American challenges notions of physician altruism, the fundamental feature of medical professionalism, and has potential implications for policy in a host of health care areas.

Author contributions: J.L., W.H.D., and S.K. designed research, performed research, contributed new analytic tools, analyzed data, and wrote the paper.

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Data deposition: The data that support the findings of this study are available publicly at https://drive.google.com/open?id=0B7gsUQh3W-l2azdRTWItMnBkaGc.

[1]W.H.D. and S.K. contributed equally to this work.

[2]To whom correspondence should be addressed. Email: kariv@berkeley.edu.

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*We will not attempt to review the large and growing body of economics research on social preferences, which includes refs. 12–17 among many others. Camerer (18) and Cooper and Kagel (19) provide a comprehensive discussion of experimental and theoretical work in economics focusing on dictator, ultimatum, and trust games.

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increasingly questioned reliance on physician professionalism as a safeguard for patients' interests and society's resources and are turning to financial rewards and penalties tied to measurement of individual physician performance (21, 22). There is also an extensive literature showing that physicians do respond to financial incentives in medical decision-making (23–27). However, some health care leaders argue that many aspects of physician performance cannot be monitored and that performance incentives can have unintended negative consequences; thus, we inevitably must rely on physician trustworthiness in much of medicine (28, 29). The optimal balance in any medical area between trust of physician professionalism and costly government regulation will depend critically on the nature of social preferences (and resulting behavioral tradeoffs) among the physicians in that area of medicine.

Social preferences may naturally be divided into two components that often operate together but are conceptually distinct—the tradeoff between altruism and self-interest (the weight on own welfare vs. the welfare of others) and the tradeoff between equality and efficiency (the weight on reducing differences in welfare vs. increasing total welfare). From Harsanyi (30, 31) and Rawls (32)—and the enormous literature that they spawned—there is certainly no a priori reason to insist that more altruistic people will necessarily place a greater weight on equality vs. efficiency.

In fact, both Harsanyi (30, 31, 33) and Rawls (32) argue that the fair-minded place equal weight on themselves and others, so that their distributive decisions "satisfy the impartiality and impersonality requirements to the fullest possible degree" (33). Harsanyi (30, 31, 33) and Rawls (32) nonetheless came to opposite conclusions about how fair-minded people should trade off equality and efficiency—Harsanyi's utilitarian view is that social preferences should maximize total welfare (efficiency), whereas the Rawlsian view is that they should minimize differences in welfare (equality). The distinctions that we draw are, therefore, straightforward and capture important differences.

Physicians' altruism—the concern for patient health and wellbeing beyond own self-interest—has been reinforced by ethical guidelines, such as those in the Hippocratic Oath; physicians constantly face decisions that involve tradeoffs between patients' health and financial wellbeing vs. physicians' self-interest (1), such as whether to recommend a lucrative procedure to patients for whom there might be little expected benefit. The other equally important component of physicians' social preferences—the tradeoff between equality and efficiency—is not addressed in the Hippocratic Oath, despite its centrality to physicians' willingness to "ration" patient access to low-benefit care in the interests of a more efficient health care system and the aggregate impact that this has on society's ability to finance needed care.[†]

Economic theory raises intriguing questions about social preferences. Insofar as social preferences are rational (in the sense of a complete and transitive preference ordering), the techniques of economic analysis may be brought to bear on modeling and predicting behavior governed by these preferences by exploring the structure of the (social) utility functions that rationalize the observed behavior. This highlights the need to develop a rigorous test of the rationality of social preferences. The problem is a difficult one. A definitive answer requires experimental techniques that are capable of generating suitably rich choice data and econometric techniques for assessing the data.

Our primary methodological contribution is an experimental technique that allows for the collection of richer data about physician preferences than has heretofore been achieved (37). Examining behavior at the individual level is a key step in properly understanding social preferences and interactions. A graphical interface was developed for this purpose, where subjects see on a computer screen a geometrical representation of choice problems and make choices through a simple point and click design. This intuitive and user-friendly interface allows for the quick and efficient elicitation of many decisions per subject under a wide range of choice scenarios.

The experiment is specifically designed to distinguish altruism from equality–efficiency tradeoffs and measure these two components of social preferences in a sample of medical students. The experiment involves allocating real money between the medical student subject herself and a random individual from the American Life Panel (ALP), a panel broadly representative of the US population. For comparative purposes, we present our medical students data alongside data collected using identical experiments with ALP subjects. Like a medical student subject, an ALP subject also divided money between herself and an individual chosen at random from among the ALP members not sampled for the experiment.

Our main findings are as follows. The subjects in our samples display widely heterogeneous social preferences. Despite this heterogeneity, we find significant differences in the social preferences of subjects across samples in terms of both their altruism and equality–efficiency tradeoffs. Specifically, the medical students are significantly less altruistic and more efficiency focused than the general population. In addition, medical students in schools ranked among the top 10 in the United States are less altruistic than those in lower-ranked schools, and medical students choosing high-income specialties are less altruistic than those choosing low-income specialties. The fact that our experimental measures predict the career choices of the medical student subjects shows that these measures meaningfully capture individual social preferences that govern real world decisions.

We further compare our sample of medical students with several elite samples: an elite ALP sample (37) (defined in *Future Physician Vs. Other Elites*), a sample of University of California, Berkeley (UCB) undergraduates (38), and a sample of Yale Law School (YLS) students (37). The medical student subjects are indistinguishable from the ALP elite subjects in terms of altruism but are more altruistic than both the YLS and UCB subjects. Furthermore, the medical student subjects are slightly more efficiency focused than both the ALP elites and UCB subjects, and they are less efficiency focused than the YLS subjects. However, there are no significant differences in altruism and equality–efficiency tradeoffs between the medical students at top-ranked schools and the sample of YLS students.

A crucial concern about this study is its external validity, as our experimental measures of social preferences of medical students have not yet been shown to predict actual physician practice behaviors. This is an open question and important topic for additional research that we plan to undertake based on extensions of this experimental design. Pending that future research on actual physician behavior, we show predictive validity by showing that the social preferences, as captured in our experiment, are related in an understandable way to the (early) career choice of medical students as well as the real world decisions of the comparator subject pools.

The rest of the paper is organized as follows. *Experiment* summarizes the experimental design and procedures, and *Subject Pools* describes the subject pools. *Empirical Framework* provides the template for analysis, and *Experimental Results* contains the results. *External Validity* summarizes closely related papers using this experimental technique, as we are building on the datasets and expertise that we have acquired in previous work (17, 37–39). This is followed by *Concluding Remarks*.

Experiment

Design. We restrict attention to dictator games and ignore the complications of strategic behavior and reciprocity motivations

[†]Physicians are central decision-makers in the health care industry (34), the expenditure on which constitutes $3.2 trillion US or 17.8% of the US gross domestic product in 2015 (35). Almost one-third of the expenditure on health care is considered wasted on care that has little benefit (36), which may be in part caused by physicians acting on self-interest as well as their unwillingness to refuse patient care requests because of social preferences weighted toward equality.

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in response games to focus on behavior motivated purely by social preferences. Nonstrategic behavior is simpler to analyze and is, moreover, adequate for decomposing social preferences into altruism and equality–efficiency tradeoffs. In the experiment, we presented subjects with a sequence of 50 decision problems. Each decision problem is presented as a choice from a 2D budget line. The budget line is a concept derived from microeconomics consumer theory, which represents all possible quantity combinations of two goods that an individual consumer can purchase given a fixed amount of monetary endowment and the prices of the two goods. In this application, the two "goods" that the subject is asked to choose between are experimental tokens (a symbolic unit that carries monetary value) allocated to self (the subject) vs. tokens allocated to an anonymous other (an ALP member chosen at random). Throughout, we denote persons self and other by s and o, respectively, and the associated monetary payoffs by π_s and π_o, respectively.

In a standard dictator experiment, self divides some endowment m between self and other in any way he wishes, such that $\pi_s + \pi_o = m$. One respect in which this framework is restrictive is that the set of feasible payoff pairs is always the line with a slope of -1, so that the problem faced by self is simply allocating a fixed total income between self and other. Since a great deal of consumer theory is built on the assumption of a simple linear budget line, we study a modified dictator game, in which self must allocate an endowment m across $\pi = (\pi_s, \pi_o)$ at prices $p = (p_s, p_o)$. Without essential loss of generality, assume that the endowment m is normalized to one. The budget line is then

$$p_s\pi_s + p_o\pi_o = 1,$$

and the subject can choose any allocation $\pi = (\pi_s, \pi_o)$ that satisfies this constraint. Thus, this configuration creates budget lines over π_s and π_o that allow for the thorough testing of the decomposition of social preferences at the level of the individual subject. Specifically, changing the relative price $p_s/p_o = \bar{\pi}_o/\bar{\pi}_s$, where $\bar{\pi}_s$ and $\bar{\pi}_o$ denote the end points of the budget line, allows us to examine individual responses to changes in the price of giving.

Procedures. Our experimental interface was incorporated into the ALP, and the experiment was conducted online under the ALP protocol. As a result, we have been able to conduct identical web-based experiments with medical student subjects and ALP subjects. The procedures described below are identical to those used by ref. 39. The medical student subjects were informed that the ALP is designed to be representative of the population of US adults (ages 18 y old and older) and were given the link to the ALP website. More information and full experimental instructions are available in *SI Appendix*.

Each decision problem in the experiment started with the computer selecting a budget line randomly from the set of budget lines that intersect with at least one of the axes at 50 or more experimental tokens but with no intercept exceeding 100 tokens. Subjects see the budget lines on a computer screen and choose allocations through a simple point and click.[‡] A choice of the allocation (x, y) from the budget line represents an allocation between accounts x, y (corresponding to the usual horizontal and vertical axes). The actual payoffs of a particular choice are as follows: self receives the tokens allocated to the y account (π_s), and other receives the tokens allocated to the x account (π_o). At the end of the experiment, the computer selected one decision round for each subject, where each round had an equal probability of being chosen, and self and other were paid the amount that they had earned in that round. Payoffs were calculated in terms of tokens and then converted into dollars, where 1 token = \$0.25.[§] Finally, we had our medical student subjects complete a postexperiment survey, which elicited their sociodemographic information as well as information on their medical education and future career choices.

The experimental design has a number of advantages over other designs. First, the choice of a bundle subject to a budget constraint provides more information about preferences than a typical discrete choice. Second, because the interface is extremely user-friendly, it is possible to present each subject with many choices in the course of a single experimental session, yielding a much larger dataset. This makes it possible to analyze behavior at the level of the individual subject without the need to pool data or assume that subjects are homogeneous. Third, because choices are from standard budget sets, we are able to use classical revealed preference analysis to decide if subject behavior is consistent with rationality and classical demand analysis to recover information about the underlying preferences.

Methodology. The modified dictator games that vary the relative price of redistribution were first used by Andreoni and Miller (16).[¶]. The graphical interface pioneered by Choi et al. (40) and exploited by Fisman et al. (17, 37–39) to analyze social preferences and by Choi et al. (41, 42) and Ahn et al. (43) to analyze risk preferences allows subjects to make numerous choices over a wide range of budget sets, and this yields a rich dataset that is well-suited to analysis at the level of the individual subject. The analysis of these experimental and field data consists of a combination of structural and descriptive work and provides corroboration of the work presented here.

The baseline experiment of Fisman et al. (17) uses budget sets over feasible payoff pairs, identical to the experiment reported here. This experiment is also identical to that of Andreoni and Miller (16), except for presenting the choice problems graphically, and therefore, the results of these studies are directly comparable. Although Fisman et al. (17) test a much wider range of budget sets than can be tested using the pencil and paper questionnaire method of Andreoni and Miller (16), the behavior elicited graphically is consistent with the behavior elicited nongraphically as well as with the behavior elicited by other means.[#]

To summarize, the experimental design has a number of advantages over other designs. First, the choice of a bundle subject to a budget constraint provides more information about preferences than a typical discrete choice. Second, because the interface is extremely user-friendly, it is possible to present each subject with many choices in the course of a single experimental session, yielding a much larger dataset. This makes it possible to analyze behavior at the level of the individual subject without the need to pool data or assume that subjects are homogeneous. Third, because choices are from standard budget sets, we are able to use classical revealed preference analysis to decide if subject behavior is consistent with rationality and classical demand analysis to recover information about the underlying preferences.

Subject Pools

Medical Students Sample. The 503 medical student subjects in the experiment were recruited from all 4 y of study in nine

[‡]It is, of course, possible that presenting choice problems graphically biases choice behavior in some particular way—and that is a useful topic for experiment—but there is no evidence that this is the case. For instance, behavior elicited graphically in the work by Fisman et al. (17) is quite consistent with behavior elicited by other means (18).

[§]The medical student subjects received their payment in Amazon gift cards, and ALP members received their payment via the ALP reimbursement system using a direct deposit into their bank account.

[¶]We will not attempt to review the enormous experimental literature on social preferences. Camerer (18) and Cooper and Kagel (19) provide excellent surveys that the reader may wish to consult.

[#]Two additional experiments are included in the analysis of Fisman et al. (17). *i*) An extensive elaboration uses three-person budget sets to distinguish tradeoffs between self and other and between other and other. *ii*) An intensive elaboration uses nonconvex sets to distinguish between choices that are compatible with well-behaved preferences (continuous, increasing, and concave) and those that are compatible only with not well-behaved cases.

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accredited Doctor of Medicine (MD)-granting medical schools around the United States. We approached 73 of all 122 accredited MD-granting US medical schools in alphabetical order. Of the 12 medical schools that agreed to participate in our study, we chose 9 schools based on their representativeness in both ranking [according to the 2015 *US News and World Report* research ranking of medical schools (44)] and geographical location, including schools in the Northeast, Midwest, South, and West regions of the country.

To show the predictive validity of the preference parameters elicited, we test whether the medical student subjects' social preferences, as measured in our experiment, are reflected in two career choices/outcomes.

i) The first career choice/outcome is the ranking of their medical school. If one considers those attending high-ranking medical schools as elite future physicians, then the social preferences of elite physicians have particular significance considering the possibility that their expert opinions have even wider influence on medical practice and resource allocation than average physicians.[‖] We thus divide the nine medical schools in our sample into two tiers. Three schools ranked among the top 10 in the nation are classified as tier 1. The remaining six schools are classified as tier 2. The numbers of medical student subjects in tiers 1 and 2 schools are 103 and 400, respectively.

ii) The second career choice/outcome is (self-reported) expected specialty choice. Comparing social preferences for medical students choosing different specialty career paths is especially meaningful in the United States, where large variation in income and practice patterns across medical specialties (46) presents potentially different opportunities for personal gains for physicians.[**] Given the disproportionately high number of specialists vs. primary care physicians in the United States (48), whether medical students sort into different specialties based on social preferences is a question of great policy interest. Of the 503 medical student subjects, 399 indicated a specialty choice in the postexperiment survey. Based on specialty income data of nationwide physician surveys (49), the income of the specialties indicated by our medical students sample averages to $323,000 across subjects. In the analysis below, we use $300,000 as the cutoff point of annual income between high- and low-income specialties. The numbers of medical student subjects that indicate high- and low-income specialties are 181 and 185, respectively.

In *SI Appendix*, Table S1, we report summary statistics on the basic sociodemographic characteristics of our medical student subjects by subsamples—tiers 1 and 2 schools and high- and low-income specialties. We also provide more information on the high- and low-income specialties classification in *SI Appendix*, Table S2.

ALP Sample. The overall sample of ALP respondents is broadly comparable to the US population in terms of demographic and socioeconomic characteristics.[††] To focus on ALP subjects comparable in age with the medical student subjects, we restrict attention to 267 subjects ages 22–32 y old. To obtain a sufficiently large sample of ALP subjects in this age range, we use data from our previous work (37, 39) collected in 2013 and 2014 as well as data from an additional round of experiments conducted in 2016. In *SI Appendix*, Table S1, we report the sociodemographic characteristics of our ALP subject pool, which contains underrepresented groups in terms of ethnicity, educational attainment, occupational status, and place of residence. As expected, the medical student subjects are more educated than the overwhelming majority of the ALP subjects, of whom 48.3% hold college degrees. Also, only 44.5% of the medical student subjects are female compared with 67.7% of the ALP subjects. With regard to ethnic diversity, the fraction of underrepresented minorities (African Americans, Latinos, and Native Americans) in the medical students sample is 10.8% compared with 38.6% in the ALP sample. We include controls for age and gender in our regression analyses below.

Empirical Framework

The most basic question to ask about choice data is whether they are consistent with individual utility maximization. If budget sets are linear (as in our experiment), Afriat's (50) theorem tells us that, if a finite dataset generated by an individual's choices satisfies Generalized Axiom of Revealed Preference (GARP), then the data can be rationalized by a well-behaved (piecewise linear, continuous, increasing, and concave) utility function $u_s(\pi_s, \pi_o)$.

We assess how nearly the data comply with GARP by calculating Afriat's (51) Critical Cost Efficiency Index (CCEI). This measures the amount by which each budget constraint must be relaxed to remove all violations of GARP. The CCEI is bounded between zero and one. The closer it is to one, the smaller the perturbation of budget sets required to remove all violations and thus, the closer the data are to satisfying GARP. We provide more details on testing for consistency with GARP in *Materials and Methods*.

Additionally, we suppose that $u_s(\pi_s, \pi_o)$ is a member of the constant elasticity of substitution (CES) family commonly used in demand analysis. The CES utility function is given by

$$u_s = [\alpha(\pi_s)^\rho + (1-\alpha)(\pi_o)^\rho]^{\frac{1}{\rho}},$$

where $0 \leq \alpha \leq 1$ represents the relative weight on the payoff for self (altruism), $\rho \leq 1$ represents the curvature of the indifference curves (equality–efficiency tradeoffs), and $\sigma = 1/(\rho - 1)$ is the (constant) elasticity of substitution. Those with $\alpha = 1$ ($\alpha = 0$) are perfectly selfish (perfectly altruistic), as they put all weight on the payoff to self (other). Those with $\alpha = 1/2$ are fair-minded in the sense that they place equal weight on the payoffs to self and other. The CES approaches a perfect substitutes utility function as $\rho \to 1$ and the Leontief form as $\rho \to -\infty$. As $\rho \to 0$, the indifference curves approach those of a Cobb–Douglas function. More generally, any $\rho > 0$ ($\rho < 0$) indicates social preference weighted toward efficiency (equality), because $p_o\pi_o$ decreases (increases) when the relative price p_s/p_o decreases.

We emphasize again that the graphical representation enables us to collect many more observations per subject, and therefore, our estimations will be done for each subject n separately. This allows us to test for heterogeneity of social preferences. We provide more details on the CES model and estimation in *Materials and Methods*.

Experimental Results

We first examine the differences in social preferences between the medical student subjects and the diverse sample of Americans in the ALP subject pool. We then examine the differences in social preferences between medical students attending tier 1 and tier 2 medical schools and between medical students choosing high-income and low-income specialties. Last, we examine the differences between the social preferences of our medical student subjects and the social preferences of the sample of elite ALP subjects, a sample of intermediate elite UCB undergraduate students, and a sample of YLS students.

[‖] Three of five current physician members of the Medicare Payment Advisory Commission, an expert panel advising Congress on Medicare issues, obtained their MD from medical schools among the top 10 in the United States (45).

[**] For instance, specialists performing medical procedures are routinely reimbursed several fold more than primary care physicians for office visits, even when visits are of similar duration (47).

[††] Fisman et al. (39) have detailed information on the ALP subject pool and a comparison of the ALP and the American Community Survey conducted by the US Census and representative of the US population. Like the US population, the ALP sample includes an enormous amount of demographic, socioeconomic, and geographic diversity. Importantly, the ALP contains subjects from underrepresented groups in terms of age, educational attainment, household income, occupational status, and place of residence.

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In each part, we begin our analysis of the experimental data by testing for consistency with utility maximization using revealed preference axioms. We then move to recovering the conceptually distinct components of the underlying distributional preferences—the tradeoff between altruism and self-interest and the tradeoff between equality and efficiency—by estimating CES demand functions for giving at the individual level. Finally, we briefly discuss results comparing social preferences between medical students and other elite samples. We provide summary statistics of CCEI and CES parameters for all samples in *SI Appendix*, Table S3.

Future Physicians Vs. the General Population. The mean and median CCEI scores in the medical students sample are 0.93 and 0.98, respectively, indicating that most medical students exhibit behavior that is optimizing in the sense that their choices nearly satisfy GARP, so that the violations are minor enough to ignore for the purposes of recovering preferences or constructing appropriate utility functions. The mean CCEI in the ALP sample is 0.87, and the median is 0.90. Although the CCEI scores of the ALP subjects are lower than those of the medical student subjects, the choices of the ALP subjects are also generally consistent with utility maximization.

Fig. 1*A* below presents the cumulative distribution functions (CDFs) of CCEI scores of both the medical students and ALP samples. The CDF of the medical students sample is skewed to the right, which provides a clear graphical illustration of the extent to which the medical student subjects did worse than choosing consistently and the extent to which they did better than the general population in the ALP sample. A bootstrapped Kolmogorov–Smirnov test (52, 53) rejects equality of the two distributions ($P < 0.001$). (Unless otherwise specified, all P values reported below are for bootstrapped Kolmogorov–Smirnov tests.)

Fig. 1 *B* and *C* presents the CDFs of the CES estimates $\hat{\alpha}_n$ and $\hat{\rho}_n$ for both samples, respectively. Fig. 1*B* shows that the CDF of the estimated altruism parameter $\hat{\alpha}_n$ for the medical students sample is skewed to the right relative to the distribution of the ALP sample ($P < 0.001$), indicating a higher degree of selfishness among future physicians relative to the general population. Fig. 1*C* shows that the CDF of the estimated equality vs. efficiency parameter $\hat{\rho}_n$ of the medical students sample also is to the right of the ALP sample ($P < 0.001$), indicating a higher degree of efficiency orientation in our sample of future physicians.

We now turn to an econometric analysis that examines the differences between the medical students and ALP samples more systematically. We define an indicator variable to denote the medical student sample and use it as the primary explanatory variable. The results are presented in Table 1. In Table 1, Without controls, we present results without individual-level controls, and in Table 1, Including controls for age and gender, we include controls for age and gender.

In columns 2 and 3 in Table 1, we present Tobit specifications with the CCEI and altruism parameter $\hat{\alpha}_n$ as the dependent variables, respectively. The Tobit specifications adjust for censoring of the dependent variable at one. The estimation results show that the medical student subjects are significantly more consistent and less altruistic than the ALP subjects after controlling for age and gender.

In columns 4–7 in Table 1, we present our regression results on equality–efficiency tradeoffs $\hat{\rho}_n$. Since several subjects have exceptionally low estimated parameter values, the distribution of $\hat{\rho}_n$ is highly skewed. We, therefore, estimate quantile regressions that are less sensitive to extreme values. We report results for the 25th, 50th, and 75th percentiles in Table 1, columns 4–6, respectively. Finally, in column 7 in Table 1, we present a probit specification with an indicator for being efficiency focused ($\hat{\rho}_n \geq 0$).

The values of $\hat{\rho}_n$ are higher in the medical students sample than in the ALP sample across all three quantiles (Table 1, columns 4–6) and in the probit specification (Table 1, column 7), indicating that our sample of future physicians is more efficiency focused than the general population, although the estimation results are not consistently significant across specifications (there is no significant difference between the medical students and ALP samples at the 25th percentile quantile regression after controlling for age and gender or in the probit specification).

Tier 1 Vs. Tier 2 Medical Schools. Fig. 2 presents the CDFs of CCEI scores $\hat{\alpha}_n$ and $\hat{\rho}_n$ for the medical student subjects by school tier. Fig. 2*A* shows that the CDF of CCEIs for those in tier 1 schools is more right-skewed than that for those in tier 2 schools ($P = 0.006$), indicating that those attending top-ranked medical schools are more consistent with utility maximization than their counterparts in lower-ranked schools. Fig. 2*B* shows that the CDF of $\hat{\alpha}_n$ for those in tier 1 schools is more skewed to the right compared with the CDF for those in tier 2 ($P = 0.009$), suggesting that medical students in top-ranked schools are less

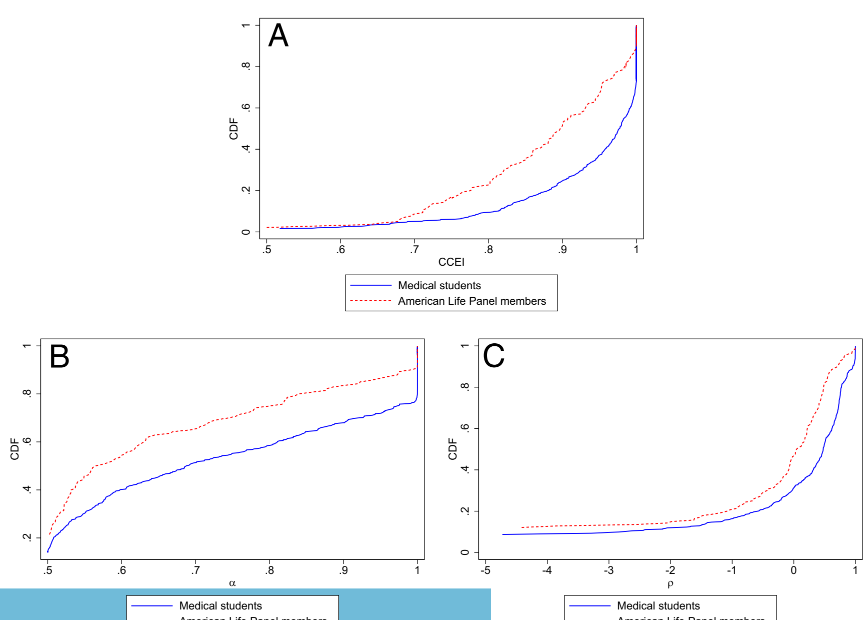

Fig. 1. Cumulative distributions of estimated CCEI (*A*), $\hat{\alpha}_n$ (*B*), and $\hat{\rho}_n$ (*C*) parameters in the medical student and ALP samples. CCEI measures consistency in decision-making: a higher value indicates greater consistency; $\hat{\alpha}_n$ measures altruism: the relative utility weight placed on one's own payoff vs. the payoff to other, and $\hat{\rho}_n$ measures the tradeoff between efficiency and equality: $\hat{\rho}_n$ values closer to one indicate greater efficiency focus.

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Table 1. Regressions of estimated CES parameters: Medical students vs. ALP

	Tobit		Quantile regressions			
Specification and dependent variable	CCEI	$\hat{\alpha}_n$	25th: $\hat{\rho}_n$	50th: $\hat{\rho}_n$	75th: $\hat{\rho}_n$	Probit:$I(\hat{\rho}_n > 0)$
Without controls						
Medical student	0.077****	0.058****	0.548***	0.451****	0.282****	0.448****
	(0.010)	(0.016)	(0.210)	(0.064)	(0.026)	(0.096)
Observations	770	770	770	770	770	770
Including controls for age and gender						
Medical student	0.076****	0.052***	0.347	0.328****	0.254****	0.372****
	(0.011)	(0.019)	(0.260)	(0.081)	(0.046)	(0.113)
Observations	770	770	770	770	770	770

SEs are in parentheses.
***Significance at the 99% level.
****Significance at the 99.9% level.

altruistic than their counterparts. Lastly, Fig. 2*C* shows that the CDF of $\hat{\rho}_n$ for students in tier 1 schools is again more skewed to the right ($P = 0.005$), indicating higher focus on efficiency vs. equality.

Table 2 presents the comparisons in a regression framework. The specifications are identical to those in Table 1 above, except that the sample consists only of the medical student subjects, and the main independent variable is an indicator for attending a tier 1 medical school. Columns 2 and 3 in Table 2, Without controls show that the medical student subjects in tier 1 schools are significantly more consistent and less altruistic than those in tier 2 schools. The coefficients are almost identical in Table 2, Including controls for age and gender after adding controls for age and gender. However, the only coefficient that is significant among the three quantile regressions in columns 4–6 in Table 2 is the one in the 50th percentile regression, both the magnitude and significance of which decrease after age and gender are controlled for. The coefficient in the probit specifications in column 7 in Table 2 is also marginally significant after controls are added.

High-Income Vs. Low-Income Specialties. Specialty choice is another relevant classification that we examined. Before presenting the results, we note that the distributions of specialty choice are similar between those in tier 1 vs. tier 2 schools: the proportion choosing high-income specialties is 57.1% among medical student subjects in tier 1 schools compared with 47.6% in tier 2 schools. The difference is statistically insignificant. Fig. 3 shows that the CDFs of CCEI scores $\hat{\alpha}_n$ and $\hat{\rho}_n$ for medical students choosing high-income specialties are all more right-skewed than those choosing low-income specialties, with the most conspicuous difference in the CDFs of $\hat{\alpha}_n$ ($P = 0.002$ for CCEI, $P = 0.002$ for $\hat{\alpha}_n$, and $P = 0.007$ for $\hat{\rho}_n$). Finally, Table 3 shows a similar set of regressions as those in Table 2 but instead, with the indicator for choosing a high-income specialty as the key independent variable. The only coefficient that is consistently (and highly) significant with and without demographic controls is the one for $\hat{\alpha}_n$ reported in column 3 in Table 3, indicating that medical students choosing high-income specialties display a greater level of selfishness relative to those choosing low-income specialties. This significant relationship between our experimental measures of social preferences of medical student subjects and their real world career choices provides a useful external validation that these experimental measures are capturing actual preferences.

Future Physicians Vs. Other Elites. In *SI Appendix*, we examine the differences in social preferences between our medical student subjects and the subsample of ALP elites in the work by Fisman et al. (37), in which an ALP subject is classified as elite if she or he is employed, reported an annual household income over $100,000, and holds a graduate degree. We also examine the differences between the social preferences of our medical student subjects and the social preferences of the sample of UCB and

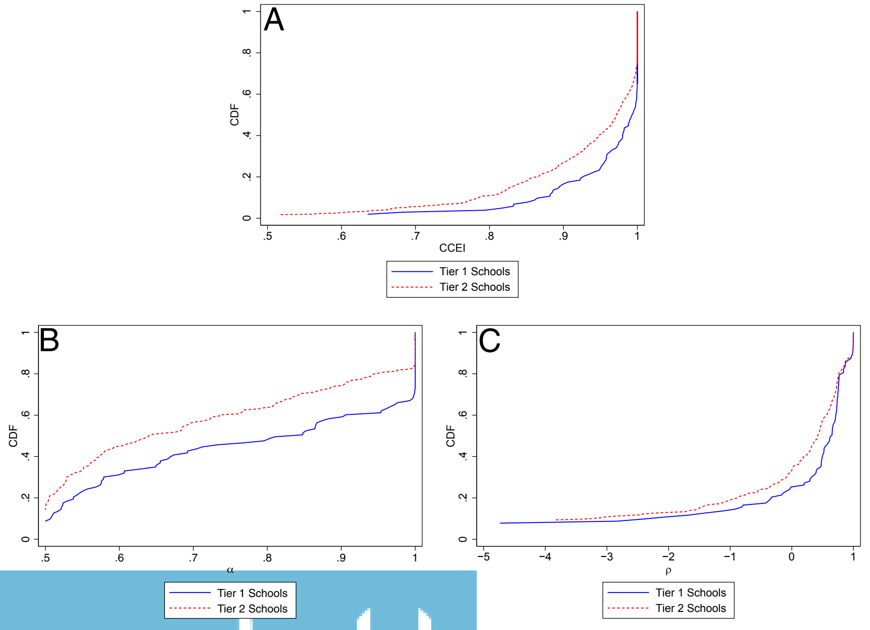

Fig. 2. Cumulative distributions of estimated CCEI (*A*), $\hat{\alpha}_n$ (*B*), and $\hat{\rho}_n$ (*C*) parameters in the medical student sample by medical school tier. Tier 1 medical schools are those that are in the top 10 of the *US News and World Report* (44) rankings of American medical schools by research. Tier 2 medical schools are those that are outside of the top 10 in the same rankings.

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Table 2. Regressions of estimated CES parameters: Medical students in tier 1 vs. tier 2 medical schools

Specification and dependent variable	Tobit		Quantile regressions			
	CCEI	$\hat{\alpha}_n$	25th: $\hat{\rho}_n$	50th: $\hat{\rho}_n$	75th: $\hat{\rho}_n$	Probit: $I(\hat{\rho}_n > 0)$
Without controls						
Tier 1 school	0.045*** (0.016)	0.063** (0.026)	0.313 (0.283)	0.203** (0.091)	0.025 (0.040)	0.220 (0.149)
Observations	503	503	503	503	503	503
Including controls for age and gender						
Tier 1 school	0.046*** (0.016)	0.063** (0.026)	0.468 (0.309)	0.191* (0.100)	0.068 (0.055)	0.265* (0.148)
Observations	503	503	503	503	503	503

SEs are in parentheses.
*Significance at the 90% level.
**Significance at the 95% level.
***Significance at the 99% level.

YLS subjects in the work by Fisman et al. (37). *SI Appendix*, Fig. S2 and Table S4 show the results comparing medical students with elite ALP subjects. The medical students are not less altruistic than the elite ALP subjects, but they are more consistent with utility maximization as well as more efficiency focused than the latter. *SI Appendix*, Fig. S3 and Table S5 show the results comparing medical students with UCB subjects. The medical students are similar to UCB subjects in terms of consistency but are more altruistic and more efficiency focused. *SI Appendix*, Fig. S4 and Table S6 show the results comparing medical students with YLS subjects. Relative to the YLS subjects, the medical student subjects are less consistent, more altruistic, and less efficiency focused. Nevertheless, perhaps most interestingly, *SI Appendix*, Fig. S5 and Table S7 show that there are no significant differences in altruism and equality–efficiency tradeoffs between the medical student subjects in tier 1 schools and the YLS subjects.

External Validity

The rich dataset that allows us to investigate the social preferences of medical students at the individual level constitutes the foundation of this paper's contribution. Our parameter estimates vary significantly across subjects, implying that social preferences are indeed highly heterogeneous. Furthermore, these social preferences vary systematically across groups and in ways that have not been well-characterized by prior studies that used different methods. We find that medical students are substantially less altruistic and more efficiency focused than the average American in the ALP. We further show that the social preferences of medical students attending top-ranked medical schools are statistically indistinguishable from the preferences of a sample of elite law school students at YLS. This last finding emphasizes the somewhat surprising aspect of social preferences that can be uncovered using our methodology and adds provocative evidence about the potential levels of and variation in altruism across different categories of physicians.

A key limitation of this analysis, however, is that our experimental measures of social preferences of medical students have not yet been externally validated against actual physician practice behaviors. Whether these measures are predictive of heterogeneity in the quality and cost of medical care provided by physicians is an open question and important topic for additional research. Pending that future research on actual physician behavior, we probed the validity of our results by showing that the social preferences of medical students, as captured in our experiment, are reflected in their (early) career choice. Specifically, medical students choosing higher-paying medical specialties are less altruistic than those choosing lower-paying specialties.

Next, we discuss results from prior studies with the different subject pools that we use as comparators—ALP, UCB, and YLS—that show how the measures of social preferences in these samples are also related in an understandable way (although undeniably imperfectly) to subjects' real world decisions in various settings. This external validity evidence from other subject pools strengthens the plausibility that medical student social

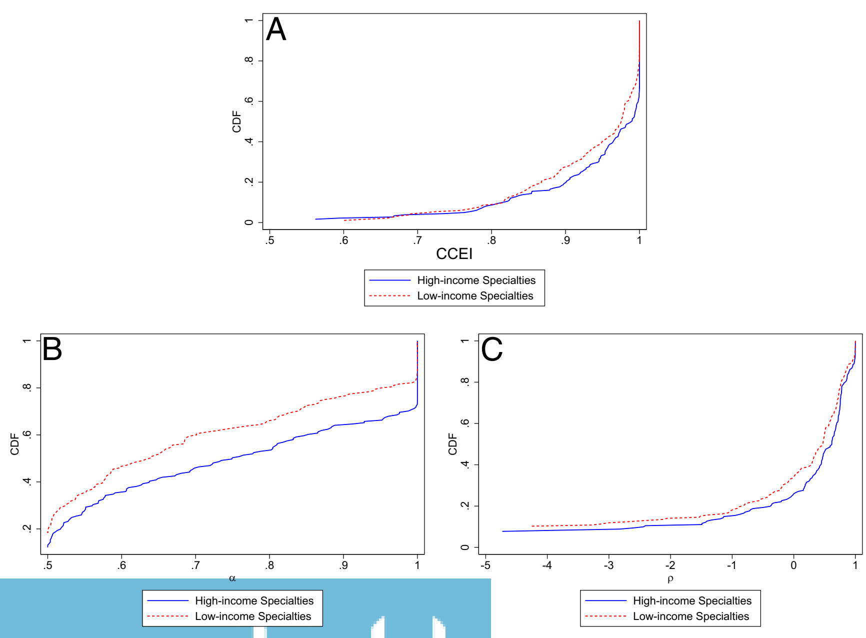

Fig. 3. Cumulative distributions of estimated CCEI (*A*), $\hat{\alpha}_n$ (*B*), and $\hat{\rho}_n$ (*C*) parameters in the medical student sample by expected specialty choice. Low-income specialties refer to those with national average income below \$300,000 US; high-income specialties refer to those with national average income above \$300,000 US.

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Table 3. Regressions of estimated CES parameters: Medical students choosing high-income vs. low-income specialty

Specification and dependent variable	Tobit: CCEI	Tobit: $\hat{\alpha}_n$	Quantile regressions: 25th: $\hat{\rho}_n$	Quantile regressions: 50th: $\hat{\rho}_n$	Quantile regressions: 75th: $\hat{\rho}_n$	Probit: $I(\hat{\rho}_n > 0)$
Without controls						
High-income specialty	0.023* (0.013)	0.064*** (0.024)	0.383 (0.313)	0.146* (0.088)	0.040 (0.040)	0.251* (0.139)
Observations	366	366	366	366	366	366
Including controls for age and gender						
High-income specialty	0.015 (0.014)	0.07*** (0.024)	0.036 (0.589)	0.112 (0.100)	0.019 (0.054)	0.097 (0.146)
Observations	366	366	366	366	366	366

SEs are in parentheses.
*Significance at the 90% level.
***Significance at the 99% level.

preferences will also be found to have meaningful external validity in future studies of actual physician behavior.

i) ALP. Fisman et al. (39) show that the equality–efficiency tradeoffs $\hat{\rho}_n$ displayed by ALP subjects in the experiment predict their political decisions—efficiency orientation is negatively related to the probability of having voted for Barack Obama in the 2012 presidential election and also negatively related to the probability of reporting an affiliation with the Democratic Party—and shed light on how American voters are motivated by their social preferences.

ii) YLS. Fisman et al. (37) show that the experimental measure of equality–efficiency tradeoffs $\hat{\rho}_n$ predicts subsequent career choice of YLS students. Fisman et al. (37) classify the YLS subjects based on employer type—nonprofit, government/academia, and corporate—and show that the nonprofit (corporate) subsample has a lower (higher) efficiency orientation relative to other YLS subjects.

iii) UCB. Fisman et al. (38) compared the experimentally measured social preferences of UCB students under the vastly different economic conditions that prevailed before and during the sharp downturn sparked by the 2008 financial crisis. They found that subjects who participated in the experiment during the downturn place greater emphasis on efficiency vs. equality and display greater levels of selfishness. This also highlights the predictive validity of our experimental measure given the complex interrelationship between the business cycle and social preferences.[‡‡]

The immediate next step for future work is to test whether our experimental measures of social preferences predict actual medical student residency specialty choice as opposed to simply the stated specialty preferences analyzed here. Even more valuable will be extending the research agenda to relate our individual-level measures of social preferences to actual physician practice behaviors, improving understanding of the characteristics of those physicians engaging in more vs. less socially desirable practice behaviors.

Concluding Remarks

The social preferences of future physicians are of particular policy interest because of the importance of the concern for patient welfare and the regard for social efficiency in the medical profession. We adopt an experimental method that allows us to measure medical students' altruism as well as how they trade off equality and efficiency. To interpret these preferences against proper benchmarks, we compare the measured social preferences of medical students with those of a general sample of the US population drawn from the ALP as well as the most highly educated, wealthy ALP subjects and samples of UCB and YLS students.

We find that the medical students are substantially less altruistic and more efficiency focused than the average American in the ALP and that the social preferences of medical students attending top-ranked medical schools are statistically indistinguishable from the preferences of a sample of elite law school students at YLS. To show the predictive validity of our experimental measure of social preferences, we associate the heterogeneity in social preferences within the medical student sample with the tier ranking of their medical schools as well as their (expected) medical specialty choice. Although we show that our experimental measures of social preferences predict the career choices of medical students, whether these measures are predictive of physicians' practice behavior and the quality and cost of medical care is an important topic for additional research.

Keeping in mind this important external validity caveat, our findings contribute evidence to debates about levels of physician altruism, which is one of the most fundamental components of physician professionalism and society's expectations of physicians. Less altruistic physicians could provide worse medical care for two reasons. First, they could literally be unscrupulous—that is, they consciously take actions that benefit them but may not benefit their patients; second and probably more important, everyone is affected by their unconscious biases (in this case, being more or less altruistic). Furthermore, existing research suggests that professional and clinical guidelines are usually insufficient to ensure that physicians act in the best interest of the patients: there is often a considerable amount of uncertainty with respect to the best clinical practice under specific situations, and it is often very difficult for the patient or the payer to monitor or judge the performance of physicians (22, 54).

To capture this wariness that some patients and payers have with regard to some physicians, economic models of physician behavior have posited that physician utility and hence, behavior are a function of both private profit and patient benefit (55–62). Previous research has documented that physician treatment decisions are indeed responsive to financial incentives in both actual practice (63–65) and in experimental studies using dictator-like games (34, 66–69). However, previous studies have not estimated the magnitude of the preference parameters underlying this tradeoff using a rich choice framework, such as that used here; thus, those studies have been less successful in modeling the heterogeneity in social preferences of those individuals or study the characteristics associated with such heterogeneity.

If future work affirms our conjecture that this experimental measure of preferences is related to physician practice behaviors and especially if our measure predicts behaviors that are not otherwise easily predictable, then this could suggest scope for improving a variety of policies and practices. For example, medical schools may consider enhancing the weight on altruism signals in the admissions process (such as volunteer history) to positively select candidates who are more likely to be altruistic. This

[‡‡]Recessionary conditions could either increase or decrease the willingness to sacrifice equality to enhance efficiency. During a recession, concerns about providing a social safety net might lead to an increased desire to rein in inequality and guarantee a minimum level of income for all, even at the expense of total output. Alternatively, conditions of scarcity may make the prospect of leaving money on the table particularly unattractive, leading to an increased focus on efficiency. The results of Fisman et al. (38) suggest that the latter concern dominates.

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may be especially relevant to elite medical schools, whose students are found to have similar social preferences to elite law students. In addition, the experimental approach used in this study may serve as an ex post tool to assess the effectiveness of the screening process in selecting altruistic candidates. More generally, future applications of our study methodology among practicing physicians can be used to further test the hypothesis that nonaltruistic preferences for financial self-interest may be an important driving factor behind the high volume of high-cost services that contributes to the persistently high health care spending in the United States—which is, in turn, partly attributed to a disproportionately higher ratio of specialists to primary care physicians than in other developed countries (46, 70).[§§]

Beyond altruism, our study quantifies the equality–efficiency tradeoff of future physicians using this cutting edge methodology, rigorously compares the social preferences of future physicians with those of the general population, and also, links these preference measures to two objective and well-defined outcomes related to physicians' career choice. It provides evidence and lays groundwork for future research that investigates physicians' social preferences in relation to actual health care, which will further inform the extent to which policymakers may want to focus on medical students social preferences, the medical school admissions process, and/or the specialty composition of physicians.

Materials and Methods

Let $\left\{(p^i, \pi^i)\right\}_{i=1}^{50}$ be the data generated by some individual's choices, where $p^i = (p^i_s, p^i_o)$ denotes the ith observation of the price vector and $\pi^i = (\pi^i_s, \pi^i_o)$ denotes the associated allocation. Then, a nondegenerate (social) utility function $u_s(\pi)$ is said to rationalize the behavior of self if

$$u_s(\pi^i) \geq u_s(\pi) \text{ for all } \pi \text{ such that } p^i\pi^i \geq p^i\pi$$

(that is, u_s achieves the maximum on the budget set at the chosen bundle). Person self is perfectly selfish when $u_s(\pi) \geq u_s(\pi')$ if and only if $\pi_s \geq \pi'_s$ and otherwise, displays some form of altruism.

Revealed Preference. We first wish to examine whether the data observed in our experiment could have been generated by an individual maximizing a well-defined utility function. If a well-defined utility function $u_s(\pi_s, \pi_o)$ that the choices maximize exists, it becomes natural to explore the structure of the utility functions that rationalize the observed data. Classical revealed preference theory (50, 71, 72) provides a direct test: choices in a finite collection of budget sets are consistent with maximizing a well-behaved (that is, piecewise linear, continuous, increasing, and concave) utility function if and only if they satisfy the GARP.

GARP (which is a generalization of various other revealed preference tests) requires that, if π^i is indirectly revealed preferred to π^j, then π^j is not strictly directly revealed preferred ($p^j\pi^i \geq p^j\pi^j$) to π^i. It is clear that, if the data are generated by a nonsatiated utility function, then they must satisfy GARP. Conversely, Afriat's (50) theorem tells us that if a finite dataset generated by an individual's choices satisfies GARP, then the data can be rationalized by a well-behaved utility function. The broad range of budget sets faced by each subject provides a rigorous test of GARP.[¶¶]

Although testing conformity with GARP is conceptually straightforward, there is an obvious difficulty: GARP provides an exact test of utility maximization—either the data satisfy GARP or they do not—but individual choices frequently involve at least some errors: subjects may compute incorrectly, execute intended choices incorrectly, or err in other less obvious ways. To account for the possibility of errors, we assess how nearly individual choice behavior complies with GARP by using the CCEI, which measures the fraction by which each budget constraint must be shifted to remove all violations of GARP (51). By definition, the CCEI is between zero and one: indices closer to one mean the data are closer to perfect consistency with GARP and hence, to perfect consistency with utility maximization. The work by Chambers and Echenique (75) has details on testing for consistency with GARP.

Econometric Specification. If subjects' choices are sufficiently consistent to justify treating the data as utility generated, Afriat's theorem (51) tells us that there exists a well-behaved (social) utility function $u_s(\pi)$ that rationalizes most of the data. Additionally, we suppose that $u_s(\pi)$ is a member of the CES family commonly used in demand analysis.[##] The primary benefit of the CES formulation is that it makes it possible to distinguish altruism from equality–efficiency tradeoffs in a particularly convenient manner. The CES utility function is given by

$$u_s(\pi) = [\alpha(\pi_s)^\rho + (1-\alpha)(\pi_o)^\rho]^{\frac{1}{\rho}},$$

where $0 \leq \alpha \leq 1$ represents the relative weight on the payoff for self (altruism) and $\rho \leq 1$ represents the curvature of the indifference curves (equality–efficiency tradeoffs).

This CES formulation is very flexible, since it "spans" a range of well-behaved utility functions by means of the parameters α and ρ: approaching perfect substitutes $\alpha\pi_s + (1-\alpha)\pi_o$ as $\rho \to 1$ and Leontief $\min\{\alpha\pi_s, (1-\alpha)\pi_o\}$ as $\rho \to -\infty$. As $\rho \to 0$, the CES form approaches Cobb–Douglas $\pi_s^\alpha \pi_o^{1-\alpha}$, which implies that the expenditures on tokens allocated to self and other, $p_s\pi_s$ and $p_o\pi_o$, are equal to α and $1-\alpha$, respectively. More generally, any $\rho > 0$ ($\rho < 0$) indicates social preference weighted toward efficiency (equality), because $p_o\pi_o$ decreases (increases) when the relative price p_s/p_o decreases.

When $\alpha = 1/2$, a subject is fair-minded, and the CES utility function approaches the utilitarian form $\pi_s + \pi_o$ as $\rho \to 1$, the Rawlsian form $\min\{\pi_s, \pi_o\}$ as $\rho \to -\infty$, and the egalitarian form $\pi_s\pi_o$ as $\rho \to 0$. In Fig. 1, we depict a budget line with $p_s > p_o$ and indifference curves consistent with these prototypical fair-minded distributional preferences. The quasiconcavity of the indifference curves measures aversion to inequality. Since the distributional preferences depicted in *SI Appendix*, Fig. S1 are fair-minded, the indifference curves are all symmetric with respect to the 45° line. Increasing α above 1/2 will shift the indifference curves toward the π_s axis.

We estimate the CES utility function in terms of expenditure shares $p_s\pi_s$ and $p_o\pi_o$ (recall that prices are normalized at each observation, such that $p_s\pi_s + p_o\pi_o = 1$). Because expenditure shares are bounded between zero and one, we generate the estimates using nonlinear Tobit maximum likelihood. To check sensitivity, we have verified that we generate virtually identical parameter values if we instead use nonlinear least squares. Fisman et al. (17) has more information on the econometric analysis.

Institutional Approval. The experiments reported in this paper were approved by the Committee for Protection of Human Subjects, which serves as Institutional Review Boards for UCB. The payoffs in the experiments depended on the subject's decisions and partly, on chance. Participation in the experiment was completely voluntary. Subjects could decline to take part in the study, could decline to answer any questions, and were free to stop taking part in the study at any time. Subjects' consent forms made clear that there is no penalty for refusing to participate, declining to answer any questions, and/or terminating their participation in the study before completed.

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[§§]The specialist to primary care physician ratio in the United States is about 70:30, while in other developed countries, it is 30:70 (48).

[¶¶]The power of the test depends on two factors. The first is that the range of choice sets is generated, such that budget lines cross frequently. The second is that the number of decisions made by each subject is large. This is a crucial point, because in most experimental studies, the number of individual decisions is too small to provide a powerful test. Building on Becker (73), the Bronars' test (74) compares the behavior of our actual subjects with the behavior of simulated subjects who randomize uniformly on each budget line. The power of Bronars' test is defined to be the probability that a random subject violates GARP. To this end, we generated a random sample of 25,000 subjects, and we found that all of them violated GARP—implying the Bronars' criterion attains its maximum value—and that their CCEI scores averaged only 0.60. If we choose the 0.90 efficiency level as our critical value for the CCEI, we find that only 12 of the random subjects' CCEI scores were above the threshold, while a large majority of actual subjects have CCEI scores above 0.90.

[##]In the case of two goods, consistency with GARP and budget balance implies that the demand function is homogeneous of degree zero. The ability to separate and homotheticity then entail that the rationalizing utility function has the CES form.

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