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The formation of physician altruism ☆

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ABSTRACT

We study how patient-regarding altruism is formed by medical education. We elicit and structurally estimate altruistic preferences using experimental data from a large sample of medical students (N = 733) in Germany at different progress stages in their studies. The estimates reveal substantial heterogeneity in altruistic preferences of medical students. Patient-regarding altruism is highest for freshmen, significantly declines for students in the course of medical studies, and tends to increase again for last year students, who assist in clinical practice. Also, patient-regarding altruism is higher for females and positively associated to general altruism. Altruistic medical students have gained prior practical experience in healthcare, have lower income expectations, and are more likely to choose surgery and pediatrics as their preferred specialty.

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1. Introduction

Altruism is a key characteristic of physicians' behavior, and the notion of a benevolent physician is deeply rooted in the medical practice and ethics dating back to the Hippocratic Oath (e.g., Pellegrino, 1987; Beauchamp and Childress, 2001). The notion of physician altruism in economics was coined by Arrow (1963), who emphasized that a physician's behavior is "supposed to be governed by a concern for the customer's welfare which would not be expected of a salesman" (Arrow, 1963, p. 949). Following Arrow, a large economics literature showed that physician altruism has important implications, for example, on physicians' responses to incentives (e.g., Ellis and McGuire, 1986; Alexander, 2020), concerns for transparency (e.g., Kolstad, 2013), referrals (e.g., Allard et al., 2011; Liu and Ma, 2013), prescription patterns (e.g., Hellerstein, 1998; Crea et al., 2019), and specialty choices (e.g., Li, 2018).

While altruism plays a key role in physicians' behavior, there is, surprisingly, little evidence about the altruistic preferences of physicians, their distribution, and their formation over time. Although medical education and training plays a major role in forming professional values and altruistic concerns for the patient (e.g., Chandra et al., 2011), the question of how medical education forms the patient-regarding altruistic preferences of future physicians is under-researched so far in the health economics literature. It is also still unclear whether the observed heterogeneity in physician altruism (Godager and Wiesen, 2013; Li, 2018; Li et al., 2022) is caused by selection into the profession or by medical education. In contrast, evidence in the economics literature exists on the formation of preferences in early childhood (e.g., Cappelen et al., 2020; Kosse et al., 2020) and on the influence of practical experience on preference formation (Malmendier and Nagel, 2015; Malmendier et al., 2020; Malmendier, 2021). Moreover, the medical education and medical ethics literature reports a decay of patient-regarding attitudes and empathy during medical education (e.g., Davis et al., 2001; Hojat et al., 2009; Stratta et al., 2016; Bordignon et al., 2020; Liu et al., 2022).

This study contributes to filling the gap in the evidence on the link between individual altruism and medical education. First, in a medically framed economic experiment, we introduce a novel behavioral measure of patient-regarding altruism that allows treating altruism as one of the 'observables' in the empirical estimations aiming at explaining the drivers of physicians' decisions and behaviors. Second, we structurally estimate altruism of medical students at different stages of their medical education. Finally, we link patient-regarding altruism of medical students to their individual characteristics and economic preferences, to their practical medical experiences, income expectations and to their stated occupational choices like preferred specialty. These contributions are based on the following research questions: How altruistic are future physicians towards patients? How is the patient-regarding altruism affected by the medical education? How does patient-regarding altruism of medical students relate to their individual characteristics, practical medical experiences, income expectations and stated specialty choices?

To address these research questions, we conduct an incentivized behavioral experiment designed to directly measure and structurally estimate the patient-regarding altruistic preferences of a large, representative sample of 733 medical students from the University of Cologne, a major university and medical school in Germany. Our experimental design involves a series of medically framed stylized decisions, in which medical students are confronted with two treatment options involving trade-offs between profits for themselves and health benefits for a patient. The patient health benefit is measured in monetary terms, and real-world patients outside the experiment benefit from the medical students' decisions as the experimental money is earmarked for cataract surgeries for real patients. Our cross-sectional sample of medical students is spread across the major stages in the six years of medical education in Germany: from freshmen and pre-clinical studies (first and second year), to clinical studies (third to fifth year), to the practical year in hospitals (sixth year).

Following the literature (Andreoni and Miller, 2002; Fisman et al., 2007; Choi et al., 2007; Bruhin et al., 2019), we structurally estimate a constant elasticity of substitution (CES) utility function with two parameters, one capturing the altruism tradeoff and the other the equality-efficiency tradeoff. The coefficients estimated using the sequence of binary choices allow us to infer the relative importance of different utility components, controlling for individual characteristics. We are particularly interested in the progress in medical studies. We include further covariates in our analyses such as socio-demographics, social and economic preferences according to Falk et al. (2018), personality traits (Rammstedt and John, 2007; Ashton and Lee, 2009), practical medical experiences, income expectations, and stated occupational preferences, all of which are elicited through an extensive post-experimental questionnaire.

Our structural estimation provides two main results. First, medical students are on average rather altruistic in that they put a weight of two thirds on the patient benefit and only one third on their own profit. Second, medical education does have a significant effect on patient-regarding altruism. In particular, we find a trend toward a U-shaped relationship between altruism and progress in medical education: compared to freshmen, medical students in the pre-clinical phase are more profit-oriented with the maximum profit orientation being observed during the clinical phase, after which altruism slightly increases again in the practical year. Our analysis also provides other important results. Our medical subject pool is found to be rather inequality averse. Linking medical students' altruism to their pre-study practical experience shows that patient-regarding altruism increases. Regarding future income expectations we find that those students who expect higher incomes put significantly more weight on their own profit than on the patient's health benefit. We also observe that medical students' altruism is significantly linked to their specialty choices for pediatrics and surgery. Finally, medical students' patient-regarding altruism is significantly higher than the one elicited among a comparison subject pool of non-medical students. The estimated effects are robust to a wide set of robustness checks controlling for medical students' gender, general altruism, other social and economic preferences, personality traits, and unobserved heterogeneity.

Our paper relates to several streams of the literature on measuring preferences among medical students and physicians. A first strand of empirical literature estimates altruism among primary care physicians using their prescription choices. Originating from Hellerstein (1998), the literature relies on a theoretical framework assuming that both the (indirect) utility of the patient and

the insurance expenditures enter the utility function of the physician.[2] Within this framework, empirical studies compare physicians' marginal utility from patient welfare with their marginal disutility from insurance expenditures (e.g., Hellerstein, 1998; Lundin, 2000; Crea et al., 2019). Making use of prescriptions data on seven different drugs from two Swedish pharmacies in 1992 and 1993, Lundin (2000) estimates a random effects probit model for whether physicians prescribed the branded or generic version of the drugs and finds some support for physician altruism: higher coverage decreased (increased) the probability of prescribing a generic (branded) version of a drug. Using a national panel register containing all statins prescriptions in Finland from 2003 to 2010, Crea et al. (2019) estimate the likelihood that physicians prescribe generic versus branded versions of statins as a function of the shares of the difference between what patients have to pay out of their pocket and what is covered by the insurance. Estimated coefficients associated with altruism are nearly zero while Crea et al. (2019) find strong evidence of habit persistence in prescribing branded drugs.[3]

A second strand of literature focuses on health benefits of patients based on experimental economics methods. Compared to studies using medical prescriptions data, behavioral experiments allow to investigate the nature of patient-regarding altruism at an individual–subject level. This approach is theoretically guided by early formalizations of physicians' behavior by Arrow (1963) and Ellis and McGuire (1986), in which a physician's utility increases in the patient's health benefit. A prototypical early example is Hennig-Schmidt et al.'s (2011) medically framed laboratory experiment with a small sample of German medical students. Using data from this experiment, Godager and Wiesen (2013) estimate the marginal rate of substitution between patient benefit and profit as a measure of physician altruism. Their estimation results show patient-regarding altruism with substantial heterogeneity. Following Godager and Wiesen (2013), Wang et al. (2020) estimate the distribution of altruism among 178 Chinese medical students and 99 Chinese physicians and compare it to those 42 German medical students participating in Hennig-Schmidt et al.'s (2011) experiment. Their estimates show that physician altruism is quite similar between Chinese doctors, Chinese medical students, and German medical students.

In a third strand of the literature, altruistic preferences of medical students are elicited experimentally in neutrally framed scenarios without a medical framing and a physician–patient relation. The experimental setting typically employs modified dictator games where altruism is identified by the trade-offs between own and other's payoffs. Following the seminal paper of Andreoni and Miller (2002), preferences over monetary sums are decomposed into two qualitatively different tradeoffs: a first tradeoff between self-interest and other's benefit, and a second tradeoff between equality and efficiency. Li et al. (2017) and Li (2018) employ an online experiment to elicit altruistic preferences of 503 US medical students over distributing monetary sums between themselves and an anonymous other person. Both studies report widely heterogeneous social preferences in terms of their altruism and equality-efficiency trade-offs. Also, Li et al. (2017) report that medical students are similar in altruism, equality and efficiency preferences compared to non-medical student subjects in comparable samples but are substantially less altruistic and more efficiency-focused than a representative sample of US citizens. Medical students in Li et al. (2017, 2022) and Li (2018) were confronted with a neutrally framed modified dictator game where the medical context was not made salient to the participants. Moreover, receivers of the medical students' money were individuals randomly chosen from a representative American Life Panel, with the health needs of the receiver not being made salient. In our study we deviate from a neutral dictator game and develop a task specifically designed to capture the medical environment prospective physicians are confronted with. Our framing includes physicians and patients, and the monetary equivalent of the patient benefit is used for patients in need of cataract surgery outside the laboratory to regain their eyesight.

The remainder of the paper is structured as follows. Section 2 provides some background on medical education in Germany and on our sample. In Section 3, we present our experimental design and procedure. Section 4 presents the behavioral results and the structural estimation results. Section 5 discusses our findings, and Section 6 concludes.

2. Background

The vast majority of prospective physicians in Germany is educated at one of the 37 public medical schools.[4] The admission to medical education is centralized nationally by the non-profit governmental Foundation for Admission to Higher Education (*Stiftung für Hochschulzulassung*), and is highly competitive, as only about one out of five applicants is admitted to a German medical school.[5] Admission criteria to medical schools, typically, are schools' grades according to the General Certificate of Education (GCE), A-levels, waiting terms,[6] and the applicants' performance in entry tests for studying medicine (TMS, *Test für Medizinische Studiengänge*). At

[2] Hellerstein (1998) assumes that the branded version of the drug is more expensive than the generic version. The model shows that, if the physician places a higher weight on the patient's utility than on insurance expenditures, an increase in the insurance coverage decreases (increases) the likelihood of the generic (branded) prescription. An increase in the insurance coverage, in fact, increases insurance expenditures and decreases patient's expenditures, *ceteris paribus*. As both these variables have a similar effect on the physician's utility, higher insurance coverage leads to a lower probability of generic prescribing when the physician values the utility of the patient more than the insurance expenditure.

[3] In this paper, we focus on physician altruism, and we do not consider studies on other healthcare providers like, for instance, Douven et al. (2019) who analyze the altruistic preferences of mental health workers using a large data set from the Netherlands. For a summary of other examples, see Galizzi et al. (2015).

[4] See, for example, *Stiftung für Hochschulzulassung*, https://hochschulstart.de/epaper/hilfe22-23/adh/index.html; (latest access, August 19, 2022).

[5] For example, in the winter term 2018/2019, according to the Stiftung für Hochschulzulassung 43,631 prospective students applied to study medicine in Germany, while only 9232 places were available.

[6] Based on their A-level and entry test scores at medical schools, applicants might need to wait for some terms before being allowed to start their medical education.

the time of data collection, 20% of the available places at medical school each were assigned to applicants with the best GCEs and to applicants based on accumulated waiting terms, respectively. The remaining places (60%) were allocated based on a medical school's individual selection criteria (e.g., TMS).[7]

The medical education in Germany is highly regulated. Structure, curriculum, and examination guidelines are standardized in the Medical Licensure Act (*Approbationsordnung für Ärzte*, ÄApprO, 2002) to ensure that all medical students obtain an appropriate and equivalent medical education. Ten of the 37 public medical schools applied specific reforms of the standardized course of study according to §41 ÄApprO, the so-called Model Course of Study. The University of Cologne (UoC) is accredited for this reformed model of medical education. In the standard and the model study courses, medical education lasts for at least six years and three months and concludes with the "Approbation", the official German license to practice as a physician, upon successfully passing the physician state exam (*Staatsexamen*). Note that medical education is *not* divided into Bachelor and Master programs.

Along the different parts of the physician exam, medical education in Germany typically comprises three phases: (i) pre-clinical phase, (ii) clinical phase, and (iii) practical year. In the first two years of the medical studies, the pre-clinical phase, students are taught the basics of medicine and natural sciences and take part in a nursing internship.[8] Traditionally, the pre-clinical phase concludes with the first part of the physician exam. Instead of one final exam at the end, medical students in Cologne take separate tests at different times of the pre-clinical phase, which serve as an equivalent to the first part of the state exam. The subsequent clinical phase comprises a minimum of three years. In this more practical phase all relevant clinical subjects are covered and students gain first experiences in practicing medicine as physician-interns in hospitals and outpatient settings prior to taking the second part of the physician exam. Medical education concludes with the practical year, the aim of which is to familiarize students with practical work in clinics. The students spend four months each at the hospital's department of internal medicine, the department of surgery, and an elective department different from internal medicine and surgery. After the practical year and having successfully completed the third part of the physician exam, medical students receive their license to practice medicine, and may start their actual specialization for a specific field in medicine.[9]

3. The experiment

3.1. General design and decision situation

We introduce a novel experimental task in a stylized medical frame to elicit patient-regarding altruism. $N = 733$ medical students each decide in the role of a physician (i) and face $J = 2$ treatment alternatives (referred to as "A" and "B" in the instructions) for 30 stylized "patients" ($T = 30$ choice occasions). Physician own profit (payment to self) is represented by s_{jt}, and o_{jt} represents the patient benefit (payment to other) for treatment alternative j and patient t. Henceforth, we use the labels "physician" and "patient" to indicate the roles in our experiment.

Physician profit as well as patient benefit are expressed in monetary terms. While all subjects in the experiment make decisions in the role of physicians for stylized patients, their choices in the experiment affect patients' health in the real world. In particular, following earlier controlled experiments on physician behavior, the monetary equivalent of the patient's benefit resulting from the treatment alternative chosen is transferred to a charity and is earmarked for surgical treatment of cataract patients.[10] The treatment of a cataract patient costs about EUR 30. For procedural details, see Section 3.2.

Each of the 30 choice occasions implies a systematically varied trade-off between physician profit and patient benefit such that one treatment alternative is always more patient-regarding, see Table 1. The values for physician profit and patient benefit can take five values: EUR 3, 6, 9, 12, and 15.[11]

[7] In line with general guidelines implying a high weighting of GCE, every medical school can decide on applying their own selection criteria. At the University of Cologne, the internal selection is based on GCE (51%) and the applicants' performance in TMS (49%).

[8] At the University of Cologne, patient-oriented teaching starts in the first semester by study-accompanying patient care. All students get patient contact in family doctor practices and have regular contact with the assigned patient and the family doctor over eight semesters.

[9] The specialization requires further training in a chosen field of medicine, for example, neurology, pediatrics or surgery. The specialization lasts for another five to six years and takes place in university hospitals or other training clinics.

[10] This procedure was introduced by Hennig-Schmidt et al. (2011) and has been applied in several experiments in health economics, as it embeds an incentive for subjects in the lab to account for real patients' health outside the lab. Equivalent mechanisms have been employed in recent behavioral experiments in health analyzing physician behavior (Hennig-Schmidt et al., 2011; Hennig-Schmidt and Wiesen, 2014; Godager et al., 2016; Brosig-Koch et al., 2016, 2017; Byambadalai et al., 2022; Di Guida et al., 2019; Martinsson and Persson, 2019; Brosig-Koch et al., 2020; Huesmann et al., 2020; Wang et al., 2020; Waibel and Wiesen, 2021; Brosig-Koch et al., 2021). In Kesternich et al. (2015) and Lagarde and Blaauw (2017), subjects could choose from several (medical) charities to which a donation should be transferred.

[11] The specific values of the treatment alternatives were chosen to guarantee that participants' average earnings correspond to the hourly wage of a student assistant at the University of Cologne (EUR 10). We excluded values of zero to avoid end points. We used the command 'dcreate' in STATA 14.0 to guide the parameterization of our choice occasions (Hole, 2015). The computerized experiment was programmed in ILIAS, a free software used as online learning platform in German universities. Medical students in Cologne are familiar with ILIAS, as it is commonly used for surveys and tests. The 30 choice occasions were shown in a pre-determined randomized order on subjects' computer screens. A subject's total payoff consisted of a physician profit (from a randomly selected patient) and a lump-sum payment for filling in the post-experimental questionnaire (EUR 5).

Table 1
Physician profit and patient benefit for treatment alternatives A and B for the 30 patients.

Patient t	Treatment A		Treatment B	
	Profit s_{At}	Benefit o_{At}	Profit s_{Bt}	Benefit o_{Bt}
1	3	15	6	9
2	3	15	9	9
3	3	15	15	3
4	3	15	6	6
5	9	15	12	12
6	6	9	15	3
7	15	3	6	9
8	3	15	6	3
9	3	15	12	6
10	9	9	3	15
11	3	9	9	3
12	15	3	3	15
13	3	15	12	12
14	3	12	12	3
15	6	12	9	6
16	3	9	6	6
17	12	12	15	9
18	3	12	15	3
19	9	6	3	12
20	6	6	3	15
21	12	12	3	15
22	12	3	3	9
23	15	6	6	12
24	6	3	3	6
25	3	9	15	3
26	6	9	3	15
27	6	9	9	6
28	15	6	9	12
29	15	9	9	15
30	6	12	15	3

3.2. Experimental protocol

The recruitment procedure was as follows. Sessions with freshmen were conducted during the welcome week, just before the start of the academic year in the medical school. Besides freshmen, we approached pre-clinical students at the end of their first year or in their second year, clinical students in their fourth year, as well as practical-year students in their sixth year.

In total, we conducted 16 experimental sessions between the summer term 2017 and the winter term 2019. We ran 11 laboratory sessions in a large lecture hall equipped with computer terminals at the medical school of the University of Cologne. The remaining five sessions were conducted online for a period of 10 to 26 days in order to reach students across all the different stages. We collected 457 (62.4%) observations via laboratory sessions and 276 (37.6%) observations via online sessions. Between November 2019 and January 2020, we also ran an online experiment with a comparison sample of 145 non-medical students of the University of Cologne, who were recruited via the online recruiting system ORSEE (Greiner, 2015).

Prior to the experiment, subjects received detailed information on the data protection, the experimental decision task, the procedure and the payment process, and gave explicit consent to participate in the study. For more details, see the instructions provided in Online-Appendix A.2. All subjects decided for the same 30 stylized patients. After subjects had taken their decisions, they were asked to complete a comprehensive questionnaire (see Section 3.4).[12]

It took subjects, on average, about 45 min to complete the decision tasks and the questionnaire. On average, medical students earned EUR 12.11 (profit EUR 7.11 plus EUR 5 for completing the questionnaire), and non-medical students were paid EUR 11.68 (profit EUR 7.68 plus EUR 4). The average patient benefit amounted to EUR 7.89 for medical and EUR 7.32 for non-medical students. In total, EUR 6846 was transferred to the *Christoffel Blindenmission*, a charity that used the money exclusively for financing cataract surgery by their own ophthalmologist staff in developing countries. Our study, thus, enabled the treatment of 228 adult cataract patients at the cost for a surgery of EUR 30. The average patient benefit of EUR 7.89, subjects realize by their decisions, is equivalent to about one fourth of the total cost of an eyesight-restoring surgery.

3.3. Medical student sample

A total of 733 medical students of the University of Cologne participated in our study from April 2017 to December 2019. Our sample consists of 440 (60%) females, the overall average age when starting medical education was 20.7, and the share of Germans

[12] Questionnaire items, which were only applicable for medical students, were dropped for the non-medical students.

Table 2
Our medical student sample in context.

	Our full sample	Comparison for the year 2017		
		Germany[a]	University of Cologne[b]	Our 2017-sample[c]
Female (%)	60.0	61.5	61.7	61.0
Age at starting medical education[d]	20.7	19.5[e]	22.5[f]	21.2
Share of Germans (%)	92.5[g]	87.3	86.5[h]	92.6[i]
Admission quota[j]				
School-leaving grade (%)	21.8	20.0	20.0	21.9
Accumulated waiting terms (%)	9.9	20.0	20.0	10.3
University-specific selection criteria (%)	68.3	60.0	60.0	67.9

Notes. For the German student population descriptive statistics are only available for the winter term 2017/2018. Our sample comprises data from both the summer term and the winter term 2017 as the University of Cologne (UoC) is one of the few medical schools in Germany where students can enroll in both the summer and the winter term, and collecting our data started in April 2017. [a]German Federal Statistical Office (Statistisches Bundesamt, 2021). Data for the winter term 2017/2018: $n = 93{,}946$; [b]Summer term 2017 and winter term 2017/2018: $n = 6034$; [c]Summer term 2017 and winter term 2017/2018: $n = 554$. Note that this is not our full sample, which also includes n = 179 subjects recruited after the winter term 2017/2018, for a total sample size of n = 733; [d]Freshmen only; [e]Data only available for average age of graduates (Statistisches Bundesamt, 2018). We, therefore, approximate the age at start of medical studies for overall Germany by subtracting the average study duration from the average age of graduates; [f]Data available only for summer term 2017: $n = 3000$; [g]Due to missing data: $n = 657$; [h]Winter term 2017 not included; [i]Due to missing data: $n = 539$; [j] The calculation of the admission quota is based on lower numbers than reported in Table 3, namely $n = 616$ for our total sample and $n = 507$ for the 2017 sample. Differences are due to procedural requirements in Germany, as some quotas are deducted from the total number of available places before allocating them to the applicants.

Table 3
Sample composition by progress stages in studies.

	Study progress stages			
	First week of studies	1st and 2nd year of studies	3rd to 5th year of studies	6th year of studies
A. Medical student sample (N = 733)				
Progress in medical studies	Freshmen	Pre-clinical	Clinical	Practical year
Main curriculum	First week of medical studies	Basic science, nursing internship	Clinical topics, physician internship	Practical work in hospital
Number of students	259	235	158	81
Share of total	35.3%	32.1%	21.6%	11.1%
B. Comparison sample of non-medical students (N = 145)				
Number of students	40	23	56	26
Share of total	27.6%	15.9%	38.6%	17.9%

Notes. Students in the comparison group are classified according to their years of studies in our four progress stages. The category "Practical year" comprises students studying in their sixth year or above. For further information on medical students' characteristics by study progress stage, see Table A.4 in Online-Appendix A.1.

by nationality is 92.5%. The sample composition is broadly representative of the medical student populations in Germany and at the University of Cologne in terms of gender, age, nationality, and admission quotas, see Table 2.[13]

The sample comprises four progress stages of medical studies: freshmen in the first week of their medical studies who did not get any prior medical education, and students from each of the three phases of medical studies (pre-clinical, clinical, and practical year). Table 3 provides an overview on the composition of our sample: freshmen 35.3%, pre-clinical 32.1%, clinical 21.6%, and practical year, 11.1%. 74% of the observations were collected in 2017 (summer and winter term) with the average response rate being 15%.[14] In the first two terms, in which we ran the experiment (summer and winter term 2017), students of all four medical school progress stages participated. To further balance our sample, we predominately recruited freshmen, clinical students, and practical year students in the winter terms 2018 and 2019. While we consider a cross-sectional data set, we constructed our sample and timed the experimental sessions such that all progress stages comprise different cohorts of medical students (defined by their starting term and year). For the distribution of students in medical progress stages by term of the experimental sessions and medical students' starting terms (cohorts), see Tables A.1 and A.2 in Online-Appendix A.1.

In addition to our sample of medical students, we study a comparison subject pool of 145 non-medical students of different majors such as business administration, economics, politics, law, history, linguistics, literature, pedagogy, and natural sciences enrolled at the University of Cologne. By doing so we check whether possible effects in altruism are specific to the medical education or may

[13] This study is part of a broader project with medical students, who participate in longitudinal experiments up to four times in the course of their medical studies.

[14] For freshmen, pre-clinical, clinical, and practical year students response rates were 43%, 23%, 11%, and 4%, respectively, of those who were invited to participate in the study. We approached students at specific study terms, and, therefore, calculated the response rates based on the total number of medical students in the respective study terms.

be found for other majors, too. The comparison subject pool matches the medical student sample in terms of years of study, see Table 3.[15]

3.4. Post-experimental questionnaire

A comprehensive endline questionnaire collected medical students' characteristics. In addition to the stage in medical studies and to standard demographics (gender and age), we collect information on subjects' personality traits, social and economic preferences, pre-study and current working experience in the medical field, and future work-related preferences (e.g., preferred specialty and future income expectations).[16]

We elicited social and economic preferences through experimentally validated survey-based methods according to Falk et al. (2016, 2018). These comprise social preferences such as general altruism, trust, positive and negative reciprocity, and time and risk preferences. The measure for general altruism[17] is of particular relevance here as it can be related to behavioral altruism, i.e., the incentivized patient-regarding altruistic choices. Additionally, we elicited subject's personality traits extraversion, agreeableness, conscientiousness, neuroticism/emotionality, and openness using the 11-item short-version of the Big Five Inventory (Gosling et al., 2003; Rammstedt and John, 2007). From winter term 2018 onwards, we use the more detailed 60-item HEXACO Personality Inventory (Ashton and Lee, 2009).[18] For a detailed description of the questionnaire items, see Table A.3 in Online-Appendix A.3.

4. Results

4.1. Descriptives and non-parametric analyses

To start with our analysis, we first focus on descriptive statistics and present non-parametric analyses. Table 4 shows the summary statistics for the percentage of patient-regarding choices (*PRC's*, Panel A). The term *PRC* refers to the treatment alternative, which provides the patient with the higher health benefit in each choice occasion. We also report summary statistics for subjects' characteristics (Panel B). Medical students decide in a patient-regarding way by, on average, making 56.3% *PRC's*. When differentiating between stages in medical studies, we find a U-shaped relationship. Freshmen are the most patient-regarding (66.0%). Patient orientation decreases in the pre-clinical phase (53.7%), reaches its minimum in the clinical phase (46.0%), and rises to 52.0% in the practical year.

Patient-regarding behavior of freshmen is significantly higher compared to students in the other progress stages ($p < 0.001$, t-test). *PRC's* in the pre-clinical phase are significantly higher than in the clinical phase ($p = 0.009$), but do not differ significantly between practical-year students and students in the pre-clinical or clinical phase ($p > 0.170$).

Fig. 1 illustrates the distributions of *PRC's* by progress stages. Except for comparing clinical-phase and practical-year students, the Kolmogorov–Smirnoff test rejects the hypothesis of identical distributions for all stage comparisons ($p < 0.05$). Fig. 1 also shows how medical students differ in their behavior. Pure profit-maximizers, who do not make any *PRC*, are located at the bottom of the graphs; for freshmen, this share is lowest (2.7%). In the pre-clinical phase, it amounts to 3.0% but increases to 15.8% in the clinical phase, while decreasing again in the practical year to 13.6%. On the other hand, the share of pure altruists, those always choosing the high-benefit alternative, is highest for freshmen (12.4%), while it is 4.3% in the pre-clinical phase, 7.0% in the clinical phase and 4.9% for practical year students.

So far, our analysis provides evidence that the majority of medical students reveal preferences that are not purely profit-maximizing and attach some weight to patient benefits. By contrast, our comparison subject pool is significantly less altruistic in all study stages. For further details on the choice behavior and descriptive statistics of our comparison subject pool, see Online-Appendix C.1.

We now turn to the characteristics of the individual participants that were elicited in the questionnaire part of our study (see Section 3.4). Panel B in Table 4 shows the descriptive statistics on subjects' social and economic preferences (general altruism, trust, positive and negative reciprocity, risk, and time discounting) as well as on subjects' personality traits (agreeableness, conscientiousness, extraversion, neuroticism/emotionality, and openness).

Altruism, trust, positive and negative reciprocity are measured on a $[0, 1]$-scale with 0 being the theoretical minimum and 1 the theoretical maximum. Risk aversion is transformed such that 0 implies risk neutrality, a positive value entails risk aversion and a negative value risk seeking. Time discounting being 0 entails patience, while a positive value implies impatience.

For our medical student sample, the general altruism measure is $M_{altruism} = 0.38$, which is below the theoretical midpoint of 0.50 and indicates that on the stated preference level, the students tend to be more selfish than altruistic. Our sample tends to be

[15] In Germany, besides medicine, study programs are typically organized as degree courses. Other exceptions are studies in law and education/teaching, which are also completed with a state exam in the sixth year. The standard period of study is typically three for Bachelor degrees and two years for master degrees, respectively. The actual study duration at the University of Cologne is, however, about four years for Bachelor and about three years for Master degrees across all fields of study.

[16] The post-experimental questionnaire comprises several other questions not analyzed here.

[17] General altruism is a measure comprising the willingness to donate to a good cause after a hypothetical lottery win, and self-assessed altruism expressed by the willingness to share with others for a good cause without expecting anything in return, see Table A.3.

[18] The HEXACO Personality Inventory elicits the same personality traits as the 11-item short-version Big Five Inventory, yet with 10 items each. As the additional trait honesty–humility is not included in the Big Five Inventory and, therefore, data is limited to 179 medical students, we neglect this trait in our subsequent analyses.

Table 4
Descriptive statistics of medical students' behavior and characteristics.

	Mean M	s.d.	N
A. Patient-regarding choices (*PRC's*)			
Total sample	16.9 (56.3%)	9.0	733
Freshmen	19.8 (66.0%)	8.1	259
Pre-clinical	16.1 (53.7%)	8.3	235
Clinical	13.8 (46.0%)	9.6	158
Practical Year	15.6 (52.0%)	9.6	81
B. Characteristics			
Social and economic preferences			
Altruism	0.38	0.17	729
Trust	0.57	0.24	729
Positive reciprocity	0.36	0.18	729
Negative reciprocity	0.47	0.16	729
Risk aversion	0.07	0.15	731
Time discounting	0.27	0.16	731
Personality traits			
Agreeableness	0.09	0.37	729
Conscientiousness	0.39	0.35	729
Extraversion	0.25	0.41	729
Neuroticism/emotionality	−0.08	0.43	729
Openness	0.27	0.44	729

Notes. This table presents summary statistics on the number of patient-regarding choices and on subject's characteristics, the latter comprising social and economic preferences according to Falk et al. (2016, 2018), personality traits by the Big Five Inventory, Gosling et al. (2003) and Rammstedt and John (2007) or the HEXACO Personality Inventory (Ashton and Lee, 2009). Altruism, trust, positive and negative reciprocity are measured on a $[0, 1]$-scale with 0 being the theoretical minimum and 1 the theoretical maximum. Risk aversion is transformed such that 0 implies risk neutrality, a positive value entails risk aversion and a negative value risk seeking. Time discounting being 0 entails patience, while a positive value implies impatience. All personality traits are measured on a $[-1, 1]$-scale. See Table A.3 in Online-Appendix A for a detailed description of all variables. The lower number of observations in Panel B is due to subjects leaving the survey before completing the questionnaire.

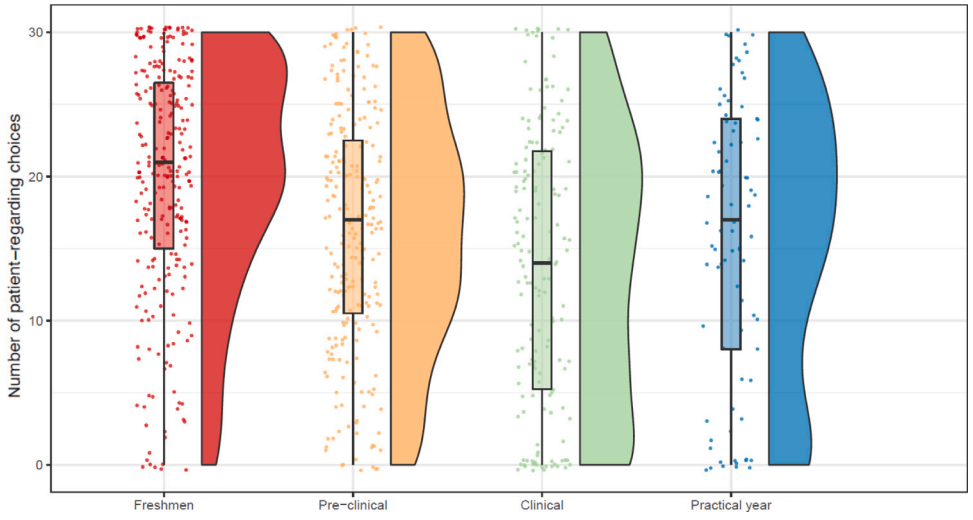

Fig. 1. Distributions of patient-regarding choices by progress stages. *Notes.* This figure shows distributions and box plots for number of patient-regarding choices by stages in studies. Pure profit-maximizers are located at the bottom of the graph and pure altruists at the top.

trusting (M_{trust} = 0.57), and is slightly more positively reciprocal than being negatively reciprocal ($M_{pos.recipr.}$ = 0.47, $M_{neg.recipr.}$ = 0.36). M_{risk} = 0.07 points to risk aversion of our participants, while the positive value for time discounting ($M_{timedisc.}$ = 0.26) indicates impatience.

All personality traits are measured on a $[-1, 1]$-scale. Regarding agreeableness and neuroticism/emotionality, the sample means are close to the neutral midpoint ($M_{agr.}$ = 0.09 and $M_{neurot.}$ = −0.08). The positive values for the remaining personality traits reveal that our students are rather conscientious, extraverted, and open ($M_{conscient.}$ = 0.39, $M_{extrav.}$ = 0.25 and $M_{openn.}$ = 0.27).

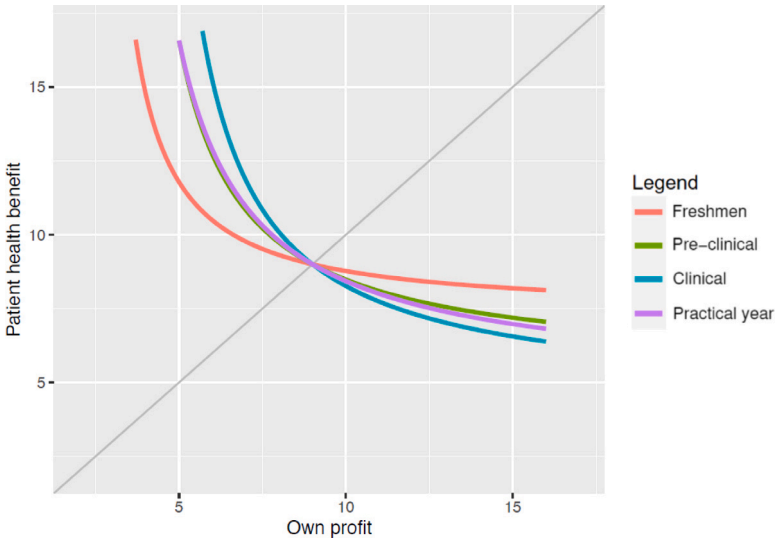

Fig. 2. Indifference curves for different progress stages. *Notes.* This figure shows the indifference curves between own profit and patient health benefit for the different progress stages based on CES preference parameter estimates from Model (2) of Table 5.

4.2. Structural estimation with observed heterogeneity

The structural estimation of altruism is based on a behavioral model widely-used in the previous literature (e.g., Andreoni and Miller, 2002; Choi et al., 2007; Fisman et al., 2007; Bruhin et al., 2019). This model assumes the physician derives a constant elasticity of substitution (CES) utility from two sources, their own profit and the patient's health benefit. The model entails two structural preference parameters: $a \in [0,1]$ which is the weight physicians put on her own profit and $r < 1$, which captures the convexity of preferences and reflects the elasticity of substitution between own profit and the patient's health benefit.[19] While a represents the altruism trade-off, r represents the equality-efficiency trade-off. We estimated both preference parameters, alongside a noise parameter, with a random utility model for discrete choices. Technical details on the behavioral model and the estimation strategy are detailed in Online-Appendix B.

Table 5 shows the estimation results. In our base model without covariates, a indicates a moderate profit orientation. Medical students put a weight of about one third on their own profit and two thirds on the patient health benefit. Parameter r is negative, implying that medical students express a tendency for inequity aversion; see Model (1) of Table 5.

Our estimation results support our non-parametric analyses. Medical students' patient-regarding altruism significantly declines with progress in medical education. Recall that a characterizes participants' own-profit orientation, and, thus, a negative (positive) coefficient for a implies an increase (decrease) in the weight subjects put on the patient benefit. Model (2) of Table 5 shows, that compared to freshmen (our reference category), the medical students in the pre-clinical phase are more profit-oriented, and profit orientation is highest during the clinical study phase. Only in their practical year, medical students' patient-regarding altruism slightly increases again compared to the clinical studies.

Fig. 2 shows the typical indifference curves for the different progress stages based on parameter estimates from Model (2). This effect of the study phase remains stable when controlling for medical students' gender, general altruism, other social and economic preferences, and personality traits; see Models (2) to (6) of Table 5. Fig. 3 illustrates the heterogeneity implied by the different sets of covariates from Model (2) and Model (6).

Our estimations show that female medical students are more altruistic towards patients than male medical students; see Model (3) of Table 5. We also observe that patient-regarding altruism is positively related to Falk et al.'s general altruism measure meaning that medical students with higher general altruism put significantly less weight on their own profit compared to the patient's health benefit. These findings are also robust when controlling for other social and economic preferences, as well as personality traits; see Models (4) to (6) of Table 5.

Overall, medical students reveal inequity averse preferences, as indicated by the estimates for the parameter r; see Model (1) of Table 5. Also, estimates for r tend to increase with progress in medical education but with no firm results when adding further controls to the regressions. Further, estimations show that women and individuals with higher general altruism have lower values of r; see Models (2) to (6) of Table 5. Noise μ tends to be lower for pre-clinical students and larger for students in practical years.

[19] Correspondingly $1-a$ represents the weight a physician puts on the patient's health benefit and the elasticity of substitution is defined as $\sigma = \frac{1}{1-r}$. Lower values of r are associated with more convex preferences.

Table 5
Aggregate estimations, preference parameters, noise and marginal effects, CES preferences.

Model:	(1)	(2)	(3)	(4)	(5)	(6)
a						
Constant	0.339***	0.209***	0.293***	0.531*	0.708***	0.739***
	(0.016)	(0.024)	(0.035)	(0.052)	(0.090)	(0.109)
Pre-clinical		0.168***	0.163***	0.154***	0.095***	0.095***
		(0.035)	(0.041)	(0.048)	(0.047)	(0.051)
Clinical		0.258***	0.257***	0.213***	0.122***	0.124***
		(0.039)	(0.043)	(0.047)	(0.050)	(0.053)
Practical year		0.189***	0.138***	0.163***	0.075***	0.081***
		(0.056)	(0.084)	(0.070)	(0.068)	(0.064)
Female			−0.111***	−0.064***	−0.041***	−0.044***
			(0.023)	(0.031)	(0.027)	(0.040)
General altruism				−0.079***	−0.056***	−0.054***
				(0.011)	(0.013)	(0.018)
r						
Constant	−0.956***	−1.240***	−0.493***	−0.354***	−0.485***	−0.364***
	(0.097)	(0.137)	(0.168)	(0.197)	(0.423)	(0.489)
Pre-clinical		0.342*	0.149*	0.132**	0.181***	0.206***
		(0.218)	(0.189)	(0.167)	(0.218)	(0.232)
Clinical		0.393*	0.183	0.254***	0.276***	0.332***
		(0.273)	(0.240)	(0.188)	(0.245)	(0.240)
Practical year		0.486*	−0.092	0.100	−0.118	−0.014
		(0.376)	(0.477)	(0.341)	(0.545)	(0.524)
Female			−1.066***	−0.490***	−0.489***	−0.424***
			(0.205)	(0.186)	(0.243)	(0.272)
General altruism				−0.101***	−0.119***	−0.105***
				(0.028)	(0.063)	(0.073)
μ						
Constant	2.623***	2.519***	2.313***	2.247***	2.007***	1.951***
	(0.092)	(0.128)	(0.170)	(0.308)	(0.487)	(0.528)
Pre-clinical		−0.198	−0.171	−0.194**	−0.149*	−0.275***
		(0.194)	(0.217)	(0.224)	(0.212)	(0.254)
Clinical		0.041	0.112	−0.106	−0.075	−0.158*
		(0.265)	(0.307)	(0.286)	(0.266)	(0.279)
Practical year		0.373	0.787***	0.552***	0.951***	0.768***
		(0.363)	(0.650)	(0.572)	(0.691)	(0.741)
Female			0.127	−0.128	−0.064	−0.006
			(0.198)	(0.200)	(0.176)	(0.215)
General altruism				0.041*	0.026	0.017
				(0.048)	(0.054)	(0.055)
Soc./econ. preferences	No	No	No	No	Yes	Yes
Personality traits	No	No	No	No	No	Yes
N	733	733	733	729	729	729
Log-likelihood	−13,331.09	−13,002.64	−12,884.71	−12,394.66	−12,028.09	−11,997.39

Notes. This table shows the estimation results of the aggregate model for the CES preference functional with progress stage, gender, and general altruism in the set of covariates. *a* represents the weight a physician puts on own profit, *r* represents the convexity of preferences, and μ is a noise parameter. Model (5) and (6) control for social and economic preferences and Model (6) for personality traits to account for observed heterogeneity. For the estimates of the full list of covariates, see Table B.2 in Online-Appendix B.4. Standard errors are clustered at the individual level. Differences in the number of observations in Models (4-6) are due to missing data on some questionnaire items.

*p < 0.10.

**p < 0.05.

***p < 0.01.

4.3. Robustness of results

We tested whether results are robust to different econometric specifications, behavioral models, and subject pools. Because one potential source of sensitivity is how the econometric model is extended to account for individual heterogeneity, we estimated a random coefficient model incorporating both observed and unobserved heterogeneity. Results are presented in Online-Appendix

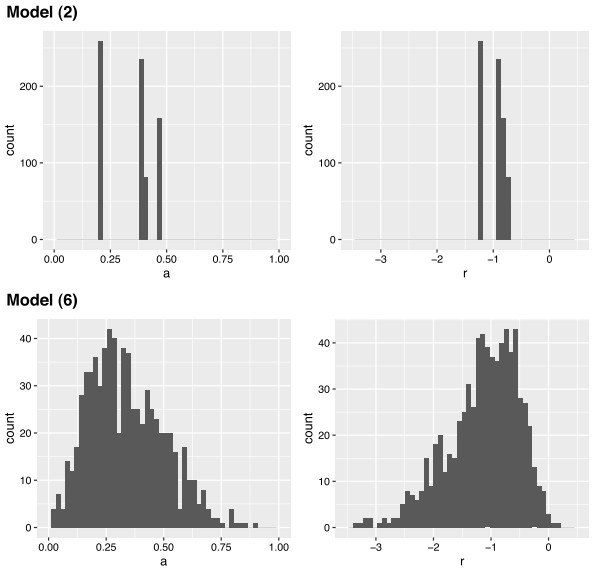

Fig. 3. Distributions of parameters *a* and *r* implied by observed heterogeneity for Models (2) and (6). *Notes. a* represents the weight a physician puts on own profit, *r* represents the convexity of preferences. Model (2) controls for different progress stages only. Model (6) includes additional controls for gender, social and economic preferences, and personality traits.

B.5.2.[20] Our findings of selfish preferences increasing with progressing in medical studies and with a maximum attained in the clinical phase are robust to estimating unobserved heterogeneity with a random coefficient model.

Our results may also be sensitive to our choice of the structural behavioral model of altruistic preferences, the CES preference utility function. To examine the robustness of our findings to this potential sensitivity, we consider a Fehr and Schmidt (1999) parametric form as another variant for the utility function. The social preference model by Fehr and Schmidt captures preferences of disadvantageous and advantageous inequality through two distinct parameters; for more details on the behavioral model, see Online-Appendix D.1. Overall, applying a Fehr and Schmidt preference functional supports our main findings that patient-regarding altruistic preferences decline with the progress of the medical studies, with the lowest altruistic preferences in students in the clinical study phase. Within the framework of the utility function, we find that our medical students are extremely averse to advantageous inequality, i.e., averse as physicians to be ahead of the patient, with clinical phase students being the least averse. At the same time, our medical student sample is somewhat averse to disadvantageous inequality, with the highest aversion attained again by clinical phase students. We provide results for the aggregate estimation in Online-Appendix D.2 and for the random coefficient model in Online-Appendix D.3.

Finally, we additionally perform all estimations for the comparison subject pool of non-medical students. In Online-Appendix C.2, we present all additional analyses for CES preferences in detail. The estimation results of each analysis are consistent with our presented main results. Further, we find that non-medical students behave less patient-regarding compared to medical students.

4.4. Experience, income expectations, and specialty choices

Practical experience (e.g., training as a nurse or a paramedic) prior to studying medicine could have contributed to the formation of patient-regarding altruism in medical students. From the finance literature, we know that experience plays an important role in the formation of risk attitudes (e.g., Malmendier and Nagel, 2015; Malmendier et al., 2020; Malmendier, 2021). In a health context, however, we are not aware of a study attempting to link past and current experiences to individuals' preferences. Also, very little empirical evidence exists on the relationship between patient-regarding altruism and specialty choice or income expectations. We only know of the Li (2018) study, which contributes to this topic. For medical students in the US, she reports a negative association between experimentally measured general altruistic preferences and their stated intentions to choose high-income specialties after graduation. It is variants of surgery like neurological, cardiac and thoracic, orthopedic as well as plastic surgery that characterize high-income specialties, while psychiatry, pediatrics and family medicine belong to the low-income specialties.

When analyzing our data, we include medical students' experience of working in the medical domain prior to entering medical school and in parallel to their medical studies, their income expectations, and their specialty choices directly in the list of covariates in our structural estimations. The questionnaire contains two variables that allow us to study how working experience in medicine

[20] Estimation results are described in Tables Table B.5 and Table B.7. Online-Appendices B.5.1 and B.6 present two additional econometric approaches, a finite-mixture model and individual estimates, as alternative ways to account for individual heterogeneity.

Table 6
Practical experience in the medical domain: Aggregate estimations and random coefficient model, preference parameters, noise and marginal effects, CES preferences.

	A. Aggregate estimation			B. Random coefficient model		
	a	r	μ	a	r	μ
Constant	0.850***	−0.017	2.139***	0.791***	0.199	0.464***
	(0.217)	(0.832)	(0.634)	(0.085)	(0.169)	(0.077)
Prior experience	−0.037***	−0.014	0.083	−0.007	0.001	0.022
	(0.035)	(0.276)	(0.426)	(0.006)	(0.009)	(0.078)
Current practical experience	−0.010	−0.216***	0.586***	0.006	−0.006	0.144
	(0.074)	(0.528)	(0.512)	(0.004)	(0.01)	(0.088)
Pre-clinical	0.036***	0.011	−0.383***	0.042	−0.002	−0.049
	(0.098)	(0.354)	(0.394)	(0.031)	(0.006)	(0.084)
Clinical	0.079***	0.189**	−0.329*	0.084***	0.012	−0.263**
	(0.132)	(0.708)	(1.167)	(0.024)	(0.016)	(0.131)
Practical year	0.051***	0.143*	−0.054	0.076**	0.028**	−0.201
	(0.09)	(0.315)	(0.573)	(0.036)	(0.012)	(0.136)
Female	−0.045***	−0.305***	−0.019	−0.047	−0.026	0.117
	(0.097)	(0.682)	(0.714)	(0.033)	(0.019)	(0.073)
General altruism	−0.039***	−0.063***	0.003	−0.035***	−0.032***	0.499*
	(0.059)	(0.16)	(0.204)	(0.005)	(0.012)	(0.261)
N	513	513	513	513	513	513
Log-likelihood	−8321.54	−8321.54	−8321.54	−3917.55	−3917.55	−3917.55

Notes. This table shows the estimation results of the aggregate model and the random coefficient model for the CES preference functional with prior experience (=1 if practical experience in the medical field exists before having started medical studies, =0 otherwise), current medical employment (=1 if current employment is related to medical studies, 0 otherwise), progress stage, gender, and general altruism in the set of covariates. a represents the weight a physician puts on own profit, r is the elasticity of substitution between the physician's own profit and the patient's health benefit, and μ is a noise parameter. The model also includes risk, time and social preferences and personality traits as covariates to account for observed heterogeneity. For the estimation results with the full list of covariates, see Tables E.8 to E.10 in Online-Appendix E. Standard errors are clustered at the individual level. The lower number of observations compared to the full sample of $N = 733$ is due to missing answers to the experience questions.

*p < 0.10.

**p < 0.05.

***p < 0.01.

relates to our measure of patient-regarding altruism; see Table A.3 in Online-Appendix A.3. The first variable measure refers to prior experience in the medical field before entering medical studies. In what follows, it is denoted *prior experience*. The second variable refers to a current employment in parallel and related to the medical studies, which we denote by *current practical experience*. In order to test the impact of experience on altruism, we re-estimate the structural model (at the aggregate level), to account for both types of experience.

About half of the medical students (51.8%) report to have prior experience, which has a significant impact on altruism as our estimation results show; see Table 6. Previous practical experience increases patient-regarding altruism with a significant decrease in the weight for own profit but no systematic impact on the convexity of preferences. Current practical experience has no systematic impact on the weight for own profit. On the contrary, current medical employment clearly increases the convexity of preferences, with less substitution perceived between own profit and patient's benefit.

Income expectations are based on a subject's self-reported probabilities that his/her expected monthly net income – five years following the completion of specialty training – falls into five different income categories.[21] When studying how individual altruistic preferences relate to specialty choices, the latter are not classified into income groups. Overall, our medical student sample (N = 693)[22] expects to earn on average EUR 4427 net per month (s.d. 737), and a median of EUR 4400. We split the continuous expected income variable at the median to facilitate the interpretation of our estimation results. In particular, the dummy variable "Expected income" in Table 7 equals 1 in case a medical student expects a future income above the median, and 0 otherwise. By adding the income variable to our previous models (see Section 4.2), we account for observed heterogeneity in expected income when estimating altruistic preferences. We find that the estimated preference parameter a is significantly higher for medical students with income expectations above the median (see left column of Panel A and B of Table 7) meaning that they put significantly more weight on their own profit than on the patient's health benefit.

[21] The five categories refer to the monthly net income of a full-time job five years after having completed the specialty education, and are as follows: (1) < EUR 3000, (2) EUR 3000 to 3999, (3) EUR 4000 to 4999, (4) EUR 5000 to 5999, (5) > EUR 5999. For each subject, we calculate an expected value for the future income expectations derived as the sum of the stated probabilities multiplied by the mean income of the respective category. In order to keep the range per category constant, we used EUR 2500 and EUR 6500 as average values for the lower and for the upper bound, respectively. When the sum of stated probabilities does not add up to 100 percent (for 82 observations), we transformed the scaling according to the probability sum.

[22] The lower number of observations is due to subjects leaving the survey before answering the question on their expected income.

Table 7
Expected income: Aggregate estimations and random coefficient model, preference parameters, noise and marginal effects, CES preferences.

	A. Aggregate estimation			B. Random coefficient model		
	a	*r*	*μ*	*a*	*r*	*μ*
Constant	0.798***	0.081	1.441***	0.618***	−0.105	0.587***
	(0.112)	(0.393)	(0.371)	(0.085)	(0.244)	(0.116)
Expected income	0.040***	0.040	0.201***	0.015***	0.024	−0.006
	(0.021)	(0.115)	(0.179)	(0.006)	(0.017)	(0.025)
Pre-clinical	0.073***	0.076*	−0.123**	0.109***	−0.006	0.006
	(0.053)	(0.168)	(0.185)	(0.033)	(0.017)	(0.029)
Clinical	0.094***	0.149***	−0.052	0.155***	0.028	−0.077**
	(0.057)	(0.195)	(0.212)	(0.039)	(0.019)	(0.037)
Practical year	0.082***	0.183***	0.151	0.146***	0.056*	−0.051
	(0.055)	(0.245)	(0.372)	(0.045)	(0.030)	(0.034)
Female	−0.035***	−0.347***	0.070	−0.021	−0.058***	0.070*
	(0.038)	(0.256)	(0.202)	(0.019)	(0.021)	(0.038)
General altruism	−0.041***	−0.049***	−0.005	−0.044***	−0.091	0.173
	(0.025)	(0.066)	(0.050)	(0.010)	(0.055)	(0.123)
N	693	693	693	693	693	693
Log-likelihood	−11,276.86	−11,276.86	−11,276.86	−5216.73	−5216.73	−5216.73

Notes. This table shows the estimation results of the aggregate model and the random coefficient model for the CES preference functional with an expected income variable (income expected five years following the completion of specialty training; =1 if expected income is above the median, =0 otherwise), progress stage, gender, and general altruism in the set of covariates. a represents the weight a physician puts on own profit, r is the elasticity of substitution between the physician's own profit and the patient's health benefit, and μ is a noise parameter. The model also includes risk, time and social preferences and personality traits as covariates to account for observed heterogeneity. For the estimation results with the full list of covariates, see Tables E.1 to E.3 in Online-Appendix E. Standard errors are clustered at the individual level. The lower number of observations compared to the full sample of $N = 733$ is due to missing answers to the expected income question.

*p < 0.10.

**p < 0.05.

***p < 0.01.

Finally, we study how altruistic preferences relate to the stated specialty choices. The four most frequently stated specialties are surgery ($N = 137$, 19%), internal medicine ($N = 110$, 15%), pediatrics ($N = 97$, 13%), and neurology/psychiatry ($N = 84$, 12%). The remaining specialties, each of which was chosen by less than 10% of our medical student sample, make up for 41% ($N = 305$).[23] Table 8 shows the estimation results of the aggregate estimation (Panel A) and the random coefficient model (Panel B). First, the effects of progress stage, gender, and general altruism remain stable when controlling for specialty choices.[24] Second, altruism is linked to the preferences for specific specialties in that stating a preference for pediatrics or surgery relates to a significantly lower own-profit orientation a; see the left column of Panel A. The random coefficient model shows that lower profit orientation is linked to the likelihood of stating a preference for pediatrics; see the left column of Panel B.

5. Discussion

We measure and structurally estimate the patient-regarding altruistic preferences of future physicians. Introducing a novel medically framed experimental design, we measure the trade-offs between own profits and the patient health benefits for a large sample of medical students ($N = 733$). The two main results of our study are that medical students are rather altruistic in that they put, on average, a weight of about two thirds on the patient health benefit and only one third on their own profit. Second, we find a heterogeneous pattern of medical students' patient-regarding altruism over the progress of their medical studies, which suggests that medical education forms medical students' altruistic preferences. Altruism is highest when students enter the medical school and significantly declines over the stages in medical studies. Only in the practical year, the last year of their medical education, patient-regarding altruism tends to increase again.

Our findings on the formation of physician altruism through medical education are robust to using a range of different structural models of altruistic preferences. Moreover, using both the CES utility function and Fehr and Schmidt' (1999) model of inequity aversion, all the structural estimations show that medical students exhibit a high aversion to advantageous inequality. Thus, prospective physicians in our experiment appear to dislike choosing a treatment that provides them with a profit higher than the patient's health benefit. Our data also show that female medical students and students scoring higher in general altruism exhibit significantly more patient-regarding altruism. Also, students with practical experience prior to their studies express a high concern for the patients' health benefit. Less profit-oriented medical students expect to earn a lower income when practicing as a physician

[23] For the full list of specialties, see Table E.4 in Online-Appendix E.

[24] The same holds for other social and economic preferences and personality traits included in the list of covariates but not explicitly reported in Table 8. The respective estimates are shown in Table E.5 and Table E.6 in Online-Appendix E.

Table 8
Specialty choices: Aggregate estimations and random coefficient model, preference parameters, noise and marginal effects, CES preferences.

	A. Aggregate estimation			B. Random coefficient model		
	a	r	μ	a	r	μ
Constant	0.757***	−0.462***	2.157***	0.612***	−0.658*	0.664***
	(0.124)	(0.613)	(0.624)	(0.055)	(0.388)	(0.088)
Surgery	−0.027**	0.069	−0.254***	−0.009*	−0.014	0.017
	(0.050)	(0.215)	(0.243)	(0.005)	(0.019)	(0.025)
Internal medicine	−0.010	0.201***	−0.536***	−0.017	−0.028	0.004
	(0.031)	(0.187)	(0.234)	(0.011)	(0.029)	(0.029)
Pediatrics	−0.032***	0.298***	−0.464***	−0.015***	0.007	−0.035
	(0.041)	(0.267)	(0.271)	(0.005)	(0.015)	(0.026)
Neurology/psychiatry	−0.020*	0.317***	−0.182	−0.006	0.015	−0.066*
	(0.052)	(0.272)	(0.312)	(0.008)	(0.015)	(0.035)
Pre-clinical	0.083***	0.145**	−0.279***	0.110***	0.002	−0.0001
	(0.048)	(0.263)	(0.290)	(0.020)	(0.015)	(0.026)
Clinical	0.113***	0.307***	−0.159	0.168***	0.038**	−0.086***
	(0.051)	(0.256)	(0.308)	(0.021)	(0.017)	(0.032)
Practical year	0.062***	−0.084	0.834***	0.135***	0.054***	−0.024
	(0.071)	(0.725)	(0.910)	(0.024)	(0.019)	(0.033)
Female	−0.049***	−0.489***	0.013	−0.050**	−0.074***	0.069**
	(0.041)	(0.335)	(0.260)	(0.022)	(0.026)	(0.030)
General altruism	−0.053***	−0.129***	0.028	−0.043***	−0.053	0.152
	(0.021)	(0.098)	(0.064)	(0.010)	(0.042)	(0.115)
N	729	729	729	729	729	729
Log-likelihood	−11,931.48	−11,931.48	−11,931.48	−5522.58	−5522.58	−5522.58

Notes. This table shows the estimation results of the aggregate model and the random coefficient model for the CES preference functional with specialty choices, progress stage, gender, and general altruism in the set of covariates. a represents the weight a physician puts on their own profit, r represents the convexity of preferences, and μ is a noise parameter. The model also includes other social and economic preferences and personality traits as covariates to account for observed heterogeneity. The lower number of observations compared to the full sample of $N = 733$ is due to subjects leaving the survey before completing the questionnaire. For the results of the full list of covariates, see Tables E.5 - E.7 in Online-Appendix E. Standard errors are clustered at the individual level.
*p < 0.10.
**p < 0.05.
***p < 0.01

in the future. Students who put a higher weight on the patient's health benefit are more likely to choose pediatrics and surgery as their preferred specialties. Finally, we find that compared to non-medical students, medical students behave more altruistically towards patients already when beginning their studies.

Our result on the strong altruism of medical students differs from estimates reported in related experimental studies (Li et al., 2017; Li, 2018; Li et al., 2022). While in Li (2018), US medical students put, on average, a weight of about two thirds on their own payoff and only one third on the payoff of an anonymous non-specified individual person, the distribution of weights on own payoff and patient benefit in our study is the opposite. This marked difference in altruism may either be caused by the two different subject pools (i.e., US vs. German medical students) or by the different features in the experimental designs. In our study, medical students decide in a medically framed setting related to their study and working environment, while related studies (Li et al., 2017; Li, 2018; Li et al., 2022) use a neutrally-framed modified dictator game, in which the medical context is not made salient to the participants; for the importance of framing on decision makers' behavior and beliefs, see, for example, Dufwenberg et al. (2011). Moreover, receivers in the dictator game are randomly chosen individuals whose potential health needs are not made salient. In our study, however, we deviate from the dictator game by developing a task particularly designed to capture the main features and trade-offs of a physician–patient decision situation the prospective physicians will be confronted with. Our framing includes physicians and patients, the monetary equivalent of the patient benefit being used for patients outside the laboratory, who are in need of cataract surgery to regain their eyesight. Making the physician–patient relationship and the health benefit salient, could potentially explain differences in the level of altruistic concerns compared to related experiments using neutral framing.

We find that medical students' patient-regarding altruism tends to exhibit a U-shaped pattern when progressing along the stages of medical education: a high degree of patient-regarding altruism when entering medical education, its steady decay in the pre-clinical and clinical stages and a slight recovery in the practical year. The decay may be explained, for one thing, by the fact that medical education follows a rather strict, predefined curriculum up to the practical year. In the more theoretically oriented phases of medical education, patients might be considered as abstract "learning objects". On the other hand, when working in clinics and healthcare institutions in the pre-clinical and clinical phase, students might realize a discrepancy between their own expectations and the professional reality. Medical ethics and education literature support this view and report a number of causes related to experiences medical students make with their teachers, mentors, and instructors. These causes are, for instance, disillusionment early on in medical education by perceived discrepancy in the quality of care patients receive (e.g., Davis et al., 2001), moral

distress (e.g., Bordignon et al., 2020; Hilliard et al., 2007; Liu et al., 2022), ethical conflicts and dilemmas[25] (e.g., Hilliard et al., 2007; Kelly and Nisker, 2009; Liu et al., 2022), emotional dissonance (e.g., Liu et al., 2022), and negative role modeling of teachers by inadequate supervision and poor professional practice (e.g., Davis et al., 2001; Paice et al., 2002); see also Kosse et al. (2020) for role models' impact in early childhood. Although the listed factors cannot be checked by our data, it seems plausible that many of them contribute to the observed decay of patient-regarding altruism in the course of medical students' education.

In the medical students' practical year, the decay in patient-regarding altruism tends to be reversed. Practical year students express higher patient-regarding altruism than students in the (preceding) clinical phase. Potential explanations are the different focus and content in this progress stage compared to the pre-clinical and clinical phases, which may contribute to the 'recovery' of medical students' patient-regarding altruism. During the practical year, medical students are integrated into the daily hospital routine on a full-time basis. They work in the obligatory specialties surgery and internal medicine and a third elective specialty. The medical education thus, relies on rather close interactions with patients which, in turn, might reactivate the ideals and expectations students had before entering medical school. Integration into the hospital day-to-day processes may have the effect that students work more self-determined and take over responsibility regarding the patients, boosting their altruistic motivation and behavior. Finally, the increase in patient-regarding altruism, observed for the practical-year students, may also be explained by a compensating effect in that students try to counterbalance the economization of German hospitals (e.g., Marckmann, 2021; Wehkamp, 2021) they might have experienced in their daily hospital work (see also Silverman and Skinner, 2004, for the US). Further, the tendency of an increased patient-regarding altruism nicely resonates with findings from related studies indicating a higher altruistic concern of physicians compared to medical students prior to their practical year (e.g., Brosig-Koch et al., 2016, 2020; Reif et al., 2020; Li et al., 2022).

Limitations. Our study has several limitations. First, one may wonder whether the observed U-shaped relationship between patient-regarding altruism and progress of university education could be specific to medical education or may be found for other majors, too. We, therefore, conducted the same experiment with a comparison group of non-medical students from different majors; see Online-Appendix C. For this group, we also find a decay in altruism over the study progress. Yet, we do not observe an increase in altruism in the last progress stage. Moreover, the non-medical students are much less altruistic than medical students when they enter the university education (Table C.1 in Online-Appendix C), suggesting that altruistic motives play an important role in the decision to enter medical school. This pattern then remains for all progress stages. The difference in altruistic motivations between medical and non-medical students is in line with findings from other experimental studies (e.g., Hennig-Schmidt and Wiesen, 2014; Brosig-Koch et al., 2016; Li et al., 2022).

Second, practical year students in Cologne are paid a financial compensation of €400 for their work as a full time employee in the hospital.[26] They thus may have a higher disposable income, which may induce them to spend more money on financing patients' cataract surgery. However, our survey data reveals that the average income of medical students in our subject pool does not significantly differ between students over progress stages. On average, medical students report a monthly income of €465 (s.d. 401) with minor differences in the stages of their studies: €458 (s.d. 397), €491 (s.d. 413), €423 (s.d. 379), and €499 (s.d. 423) for freshmen, pre-clinical phase, clinical phase, and practical-year students, respectively.[27]

Third, one might ask how well students actually are informed about their future income and whether this knowledge affects their altruism. This question is important as the perceived knowledge about future incomes may have an influence on the enrollment into medical studies and the specialty choices (e.g., Li, 2018; Bernhofer et al., 2022). We find that less profit-oriented medical students expect to earn less when practicing as a physician. Income expectations are based on a subject's self-reported probabilities that his/her expected monthly net income of a full-time job five years after having completed their specialty education falls into five different income categories, see footnote 21. Medical students in our sample have rather correct expectations of €4427 net per month (median: EUR 4400), compared to actual average income data of physicians employed in hospitals or comparable public or private institutions of €4435.[28] Students' estimations are substantially lower, however, compared to incomes of self-employed physicians running their own outpatient practice.[29]

Finally, one might argue that our cross-sectional data set would not allow us to separate the influence of medical education on patient-regarding altruism from mere cohort effects (see for the importance of this distinction Schnell and Currie, 2018). At the medical school of the University of Cologne, students can enroll in the summer and the winter term. This typically results in four

[25] Students may get into ethical conflicts and dilemmas even by observing or being involved in fraud such as claiming unjustified reimbursement by upcoding patient diagnostic related groups (DRGs) (see Silverman and Skinner, 2004; Hennig-Schmidt et al., 2019).

[26] In some hospitals, the compensation is higher. Yet, not all hospitals pay a compensation as paying is not mandatory according to the Medical Licensure Act.

[27] Comparisons based on two-sided t-tests reveal no significant differences between the means with p-values ≥ 0.155. Due to missing data the income analyses are restricted to 486 medical students of our sample.

[28] Own computations based on salaries according to collective agreements in 2017 for specialists with five years of professional experience after graduation. We computed the average monthly gross salary applicable for municipal hospitals, university hospitals and ten (large) private companies operating hospitals and health care facilities in Germany. Income tax for unmarried tax payers and mandatory solidarity fees in 2017 are deducted to achieve the monthly net income. The respective websites our data are taken from are available upon request.

[29] Based on data of the Zi Practice Panel (ZiPP), a rather large variation in monthly net income between specialties exist and range from €4160 for psychotherapy to €17,980 for radiology with an average of €8580. Own computations are based on ZiPP data available for annual income per practice owner differentiated by specialty in 2017 (Table 25 in the ZiPP annual report; https://www.zi-pp.de/veroeffentlichungen.php). Income tax for unmarried tax payers and mandatory solidarity fees are deducted. Note, however, that the ZiPP data comprise physicians with all years of practice experience. Net monthly income averages, therefore, would be much lower if the data were restricted to physicians' income received five years after having completed specialty training.

cohorts in the pre-clinical phase with a cohort being defined by the starting term and year. In the clinical and practical-year phase the number of cohorts is generally larger than six or two, respectively, depending on the study progress of the individual students. Based on the cohort structure, we carefully constructed our sample and timed the experimental sessions such that all progress stages comprise different cohorts of medical students. This provides some variation in cohorts. Table A.2 in Online-Appendix A.1 provides an overview of the distribution of cohorts of medical students in the different progress stages. For example, three different cohorts of medical students (i.e., summer 2017, winter 2017, and winter 2018) are in the freshmen stage and three cohorts (with more than 10 students) are in the pre-clinical stage (i.e., summer 2016, winter 2016, and summer 2017). Some cohorts even occur in different progress stages. Despite this variation of cohorts within medical education stages, a longitudinal data set with individual medical students followed up over the stages of their education would be needed to rigorously address this concern, which would be an important avenue for future research.

Further research contributions. Notwithstanding these possible limitations, from a research perspective, our study provides new evidence and original insights, and it speaks to, advances, and complements several streams of the economics literature. First, the notion of physicians' altruism as elicited by our new incentive-compatible experimental task is conceptually closely in line not only with the seminal theoretical models by Arrow (1963), Ellis and McGuire (1986), and Blomqvist (1991), but also with some recent models of physicians' decision making which have been empirically tested and validated using large administrative data sets.

Clemens and Gottlieb (2014), for example, assume that physicians act partly as agents on patients' behalf. They model physicians' altruism by capturing the patient's health benefit of marginal care as directly entering into the physician's utility function. Their model describes how physicians' altruism interplays with their own financial incentives and predicts that "physicians supply care up to the point where their profit margins equal effort cost less their agency benefit from improved patient health" (Clemens and Gottlieb, 2014, p. 1335). Crucially, when physicians value the patients' health benefits, their provision of health care responds less strongly to prices than it would on the basis of financial motives alone. This typically happens when health benefits diminish quickly as the market moves down the marginal benefit curve, as in the cases of emergency care and chemotherapy, which have high benefits only for small fractions of the patients' population.

Using Medicare reimbursement data from the US, Clemens and Gottlieb (2014) test the prediction that physicians' altruism translates into responses that differ based on the marginal benefit of health care. They investigate which type of health care services respond to reimbursements by dividing them into more or less discretionary services. The more discretionary services include a range of non-essential or "elective" procedures for which the timing of the treatment is highly discretionary (e.g., joint replacement, cataract removal). Less discretionary services include, for example, essential procedures for cancer and dialysis. Clemens and Gottlieb (2014) find that around two-thirds of the response by physicians translate into changes in more discretionary and elective procedures. These findings are consistent with the role of altruism in physicians' decisions in their model, which implies low elasticities when benefits drop off sharply for marginal patients, as in the case for less discretionary services. Clemens and Gottlieb (2014), therefore, found that financial incentives indeed significantly affect physicians' provision of health care and that, because of altruism, physicians disproportionately adjust their supply of relatively elective treatments as reimbursements increase, as predicted by their model.

Schnell (2022) models heterogeneity in physicians' altruism in the context of prescribing opioids in the presence of a secondary market. In her model, physicians care about the health impact of a prescription they write even if it is consumed by someone who gets it on the secondary market, whereas the physicians do not derive utility from patients' tastes about opioids. When prescribing opioids in the presence of a secondary market, therefore, physicians compare the expected health impact that a prescription will have on whoever ends up consuming it, weighted by their concern for this impact, to the revenue they receive from an office visit. Her model predicts that, looking across physicians, the presence of a secondary market will generally increase prescribing differences between strict and lenient prescribers: the secondary market polarizes physician behavior by making strict physicians becoming more strict and lenient physicians becoming more lenient. Schnell (2022) uses Medicare and other US data to empirically test her model. She groups physicians in different levels of altruism as based on their responses to the reformulation of OxyContin in 2010 after criticisms about its abuse and diversion in the secondary market. Given that the reformulated version of OxyContin has less abuse potential, physicians who are concerned with population health should be more likely to prescribe OxyContin once it had been reformulated (high altruism), while physicians who care more about maintaining their revenue should be more willing to switch to other opioids (low altruism).

Schnell (2022) finds pronounced heterogeneity in responses to the OxyContin reformulation among physicians: 41.6 percent of the physicians could be categorized as high altruism providers, 34.8 percent of physicians as low altruism providers, and 23.6 percent as medium altruism providers (no consistent change in prescriptions). Consistently with her theoretical model, opioid prescriptions are decreasing in provider altruism. Empirical estimates also confirm that low altruism physicians place the least weight on the impact they have on patients' health and have greater concern for their revenues.

Both Clemens and Gottlieb (2014) and Schnell (2022) thus highlight the key heterogeneity in, and the complex trade-offs between, physicians' altruism and incentives. Clemens and Gottlieb (2014) operationalize physician altruism as the capability of physicians of reacting differently to reimbursement rates depending on whether the health care services prescribed to the patients are elective or essential. Schnell (2022) operationalizes physician altruism as the ability of physicians to change their opioids prescriptions in response to a reformulated product with less abuse potential. Schnell's (2022) operational definition of altruism is in a similar spirit as the ones in Hellerstein (1998), whose theoretical and empirical models define physicians' altruism as the weight that physicians place in their utility function on the welfare of their patients when they decide to prescribe either a branded or a generic version of a drug. Similar conceptual or empirical frameworks have been used by, for example, Crea et al. (2019),

Granlund (2009), and Lundin (2000) when looking at the choices by physicians of prescribing generic versus branded versions of the same drug.

The present study contributes to this literature by proposing a direct measure of physicians' altruism. Rather than inferring physicians' altruism from their prescriptions or treatments decisions, physician altruism is directly elicited in an incentive-compatible experimental task where physicians face explicit trade-offs between their own revenues and patients' benefits. While not employing measures of altruism, a similar data-linking approach has already been used by Cutler et al. (2019) to directly measure physicians' beliefs using vignettes and 'strategic surveys' (Ameriks et al., 2011). A direct experimental measure of physician altruism like the one we propose here can be easily introduced in other physicians' panels and surveys around the world, thus contributing to treating altruism as one of the 'observables' in the empirical estimations aiming at explaining the drivers of physicians' decisions and behaviors. This, in turn, has the potential to lead to more precise estimates of the heterogeneous responses to financial incentives when using empirical strategies such as the ones employed by Clemens and Gottlieb (2014) and Schnell (2022).

Second, and relatedly, our study contributes to an even broader literature on what drives physicians' decisions and behaviors. By contributing to treating altruism as one of the 'observables' driving physicians' decisions and behaviors, our direct experimental measure of altruism can integrate, complement, and qualify other key factors that have been documented to affect physicians' behaviors and decisions: from financial incentives and insurers' payments (Clemens and Gottlieb, 2014, 2017; Clemens et al., 2017) to expertise and skills (Currie and MacLeod, 2017, 2020; Chan et al., 2022), from medical education and training (Doyle et al., 2010; Schnell, 2022) to peer effects and professional networks (Soumerai et al., 1998; Chandra and Staiger, 2007; Epstein and Nicholson, 2009), from management practices (Bloom et al., 2015; Tsai et al., 2015) to practice styles (Currie et al., 2016; Molitor, 2018; Currie and MacLeod, 2020; Eichmeyer and Zhang, 2022), from behavioral biases and propensities (Dawes et al., 1989; Baumann et al., 1991; Loewenstein, 2005a,b; Frank and Zeckhauser, 2007; Mullainathan and Obermeyer, 2022) to preferences and beliefs (Berndt et al., 2015; Cutler et al., 2019).

Finally, our study also contributes to the growing literature on the ability of behavioral economics measures for risk, time, and social preferences to predict real-world health outcomes ('external validity') (Barsky et al., 1997; Anderson and Mellor, 2008; Chabris et al., 2008; Harrison et al., 2010; Sutter et al., 2013; Golsteyn et al., 2014; Bradford et al., 2017; Campos-Mercade et al., 2021).

Policy implications. From a policy perspective, the observed heterogeneity in future doctors' patient-regarding altruism across different stages of medical education gives rise to several further questions. How should the selection process of students for medical schools be designed to cope with the decay in patient-regarding altruism during medical education? How should medical education be organized to maintain the high level of altruism at study entrance when the medical students enter their professional life? How should payment incentives be designed to address the heterogeneity in altruism, and to tackle such issues as physician shortage in certain specialties?

First, we find that the high initial level of altruism cannot be maintained up to the practical year. Assuming that this decay in altruism would occur for all types of medical students, this finding raises the question of how to select prospective students. This issue becomes particularly relevant in light of projections on dramatic physician shortage (see also below), which might require to expand the number of students admitted to medical schools. If the admission rates to medical schools were to be increased, medical students could enroll who originally did not intend to become physicians from the outset. This, in turn, could lead to a self-selection of less altruistic individuals into medical education, as suggested by our analysis of the comparison sample of non-medical students and by previous evidence (Hennig-Schmidt and Wiesen, 2014; Li et al., 2017; Li, 2018; Li et al., 2022). This change in the structure of altruism in medical students might affect their choices of specialties and their responses to incentives (see below). It thus seems essential to include some measure of patient-regarding altruism in the list of criteria to grant admission to medical school (Lowe et al., 2001); see for non-experimental behavioral approaches (Gafni et al., 2012).

Second, altruism is a key aspect of physicians' professional norms and in physician–patient interactions (Pellegrino, 1987). To this end, patient-oriented communication is increasingly integrated in the curriculum of medical education like, for example, in German medical schools.[30] Study-accompanying patient care allows students to experience aspects of outpatient medical care and long-term trust relationships between family doctor and patients. Increasingly, taking responsibility for patients by practical-year students may be a further reason why the decay in patient-regarding altruism is attenuated during their year in hospital practice.

Third, although patient-oriented teaching has found its place in the curriculum, the decay in medical students' altruism due to a discrepancy between their own expectations and the professional reality does not seem to have been adequately accounted for by medical education policies to date. It is not only that medical attitudes, ethical behavior, and social skills need to become an inherent part of the curriculum through continuous mandatory courses for future doctors (e.g., Strube et al., 2011; Wicks et al., 2011). As Bowman (2010) stresses, an enormous gap exists between ethics in the abstract and its daily embodiment in the provision of care. The challenge of ethics in practice is not to provide logical, rigorous and intellectual analysis of moral problems but to live and embody ethics, values and virtues. This can be done by proactive rather than reactive measures (e.g., Jagsi and Lehmann, 2004), for instance, by fostering role modeling (e.g., Davis et al., 2001), encouraging students to discuss ethical issues as they arise (Kelly and Nisker, 2009), using simulated settings also when teaching ethical behavior and social skills (e.g., Seifart et al., 2022), implementing new structures for sustainable ethical decision-making processes such as "Ethics Consultants on the Ward" (Ranisch et al., 2021), and

[30] In Germany, the 2002 Medical Licensure Act allows universities to introduce specific reforms of the standardized model of medical education. One focus is patient-centered education, which has implications for the medical curriculum. Like several other medical schools, the University of Cologne introduced a reformed model of teaching in 2003/2004 (Zims et al., 2019). Patient-orientation is now an essential part of teaching, in particular by 'StudiPat', a program of study-accompanying patient care, which is relevant for the students' grading. Starting from the first semester and lasting for four years, students make regular contact with an assigned patient and a general practitioner accredited by the statutory health insurance.

life-long learning of teachers and supervisors (e.g., Day et al., 2021), which has been reported to promote a shift in their perspectives and approaches that will help to mentor and guide medical students in an other-regarding way.

Fourth, the link between medical students' patient-regarding altruism and their occupational choices is important as it may also explain some of the key occupational choices by future physicians (e.g., Pfarrwaller et al., 2022). For example, our results can also inform the ongoing policy debate about the trends and determinants of physician shortages. Recent projections on dramatic physician shortages in Western countries reveal high variations across specialties.[31] These do not account for potential COVID-19-related impacts which are likely to exacerbate the problem. More generally, empirical evidence to date is not fully conclusive on which factors are influential for selecting a particular specialty and on the impact of medical students' preferences therein. The literature has already identified several factors that can possibly influence specialty choice by physicians.[32] Our study suggests that specialty choices are related to another key factor, which is formed in the course of the medical education: physicians' altruistic preferences towards their patients.

Finally, knowledge on the distribution of patient-regarding altruism and how it is shaped during medical education can inform the discussion about the design of financial incentives for physicians and other healthcare professionals (e.g., Ashraf et al., 2014a,b; Ashraf and Bandiera, 2017; Lagarde and Blaauw, 2017; Deserranno, 2019; Ashraf et al., 2020; Wagner et al., 2020). The high degree of patient-regarding altruism expressed in our sample implies that, in order to realize the first-best service volume (e.g., Ellis and McGuire, 1986), it may be necessary to include some element of supply-side cost sharing in the payment system. When providers are partially altruistic towards their patients, too high a degree of patient-regarding altruism could be distortionary and reduce social welfare (e.g., Makris and Siciliani, 2013). For future physicians with low patient-regarding altruism, a low rate of supply-side cost sharing would be optimal. Further, the less altruistic physicians would respond stronger to incentives from pay for performance schemes (e.g., Olivella and Siciliani, 2017). Whenever a third-party payer is constrained to offer the same payment method to all providers, differences in patient-regarding altruism in the sample of physicians would make it impossible to implement an optimal payment mechanism that motivates a first-best provision of care (Jack, 2005). In such a 'one-size-fits-all' payment scheme, the rate of supply-side cost sharing needs to be such that the more patient-regarding providers harvest rents in order to ensure the participation of the less patient-regarding providers. However, offering different modes of payment, for example, with different degrees of supply-side cost sharing, can be an efficient way of sorting individuals according to their patient-regarding altruism (e.g., Jack, 2005).

6. Conclusion

We propose a new, incentive-compatible, experimental task to measure altruistic preferences of future physicians. The task directly elicits the trade-offs between the physicians' profits and the patients' health benefits. We use such a novel task and structural econometrics to measure and structurally estimate the parameters of preferences of a large sample of medical students in Germany.

We find that medical students in our sample are altruistic: on average they put a weight of about two thirds on the patients' health benefits and only one third on their own profits. We also find that medical education affects physicians' altruistic preferences: altruism is highest when students enter the medical school and significantly declines over the stages in medical studies; only in the practical year at the end of the medical education, altruism slightly increases again. Finally, our measure of altruism significantly predicts the occupational choices of medical students.

Our findings highlight the importance of directly capturing physicians' altruism and preferences through a specific elicitation task. A direct measure of physician altruism can be easily introduced in other physicians' panels and surveys around the world, thus contributing to treating altruism as one of the 'observables' in the empirical estimations which aim at explaining physicians' decisions and behaviors. This is important because a growing number of economic studies have used a variety of proxies for physicians' altruism, indirectly inferring it from their prescriptions or treatments decisions, for example. Among other things, a direct experimental measure of altruism can lead to more precise empirical estimates of the physicians' heterogeneous responses to treatments, to clinical guidelines, and to health care policies, including policies about reimbursement rates, insurers' payments, and other financial and non-financial incentives.

Appendix. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jhealeco.2022.102716.

[31] In the UK, the highest shortages are expected in psychiatry, general medicine and emergency (Taylor, 2020; British Medical Association, 2021) while in the US, this is in primary care, and surgery (Association of American Medical Colleges, 2021). Also in Germany, projections vary massively by specialty. For surgery as well as for general medicine nearly half of the current positions are expected not to be filled in the future, and thus every second position would remain vacant. In contrast, about 77% more practical-year students want to become pediatricians than there are positions to fill (Jacob et al., 2019).

[32] These are, for instance, expected income (Bazzoli, 1985; McKay, 1990; Nicholson, 2002; Thornton and Esposto, 2003; Gagné and Léger, 2005), non-monetary factors such as expected working hours (McKay, 1990), regular working schedules (Thornton and Esposto, 2003, Dorsey et al., 2003), and procedural work or academic opportunities (Sivey et al., 2012).

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