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# Doctor–patient differences in risk and time preferences: A field experiment

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ABSTRACT

We conduct a framed field experiment among patients and doctors to test whether the two groups have similar risk and time preferences. We elicit risk and time preferences using multiple price list tests and their adaptations to the healthcare context. Risk and time preferences are compared in terms of switching points in the tests and the structurally estimated behavioural parameters. We find that doctors and patients significantly differ in their time preferences: doctors discount future outcomes less heavily than patients. We find no evidence that doctors and patients systematically differ in their risk preferences in the healthcare domain.

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## 1. Introduction

The doctor–patient interaction is generally modelled as an agency relationship (Iizuka, 2007; McGuire, 2000; Stavropoulou, 2012). Due to information asymmetry, the doctor acts as an agent making decisions on behalf of the patient. In a perfect agency model, doctors' decisions should reflect patients' preferences. In the case of health decisions patients' risk preferences – the desire for taking a gamble – and time preferences – the degree to which the present is valued more than the future – are of particular interest (Bradford et al., 2014; Bradford, 2010; Cairns and Van der Pol, 1997; Dolan and Gudex, 1995; Gafni and Torrance, 1984; Gurmankin et al., 2002; van der Pol and Cairns, 2001, 2002, 2008; Van Der Pol, 2011; Van Der Pol and Cairns, 1999). The agency relationship may not be perfect as doctors cannot easily observe or interpret patients' preferences (Fagerlin et al., 2011; Say and Thomson, 2003; Ubel et al., 2011). If doctors make decisions on the basis of their own rather than patients' preferences, it is important to understand whether the two parties have similar preferences for risk and time.

The importance of risk and time preferences in medical decision-making has been extensively discussed in the medical literature. From screening tests (Edwards et al., 2006) and general practice (Edwards et al., 2005) to specialist visits for cardiovascular conditions (Waldron et al., 2010), almost every doctor–patient consultation involves a discussion of the trade-offs between risks and benefits of treatments over time before a treatment decision is made (Zikmund-Fisher et al., 2004). Evidence suggests that doctors' risk and time preferences affect treatment decisions (Allison et al., 1998; Fiscella et al., 2000; Franks et al., 2000; Holtgrave et al., 1991); and that patients' risk and time preferences have an impact on the uptake of vaccinations, preventive care, and medical tests (Axon et al., 2009; Bradford, 2010; Bradford et al., 2010; Chapman and Coups, 1999; Picone et al., 2004) and on treatment adherence (Brandt and Dickinson, 2013; Chapman et al., 2001). This means that if doctors and patients vary in terms of risk and time preferences and doctors

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cannot readily observe these differences, doctors may recommend treatments that are not optimal given patients' risk and time preferences, which may result in lower treatment adherence. Treatment adherence is of major concern and has been shown to vary across individuals (WHO, 2003). Some of this variation may be due to differences in risk and time preferences between doctors and patients. Better matching of doctors to patients may therefore improve health outcomes through better treatment allocation and adherence.

Although the medical literature provides broad evidence on the key role of doctor–patient communication on healthcare decisions (Bjerrum et al., 2002; Dudley, 2001; Fagerlin et al., 2005a, 2005b, 2005c; Kipp et al., 2013; Ortendahl and Fries, 2006; Peele et al., 2005), there is little evidence on whether patients and their doctors have similar or different risk and time preferences. This gap in the evidence is largely due to the lack of primary data that directly measure, in a quantitatively comparable way, risk and time preferences across patients and doctors.

Moreover, there is now broad evidence that risk and time preferences are largely domain-specific (Attema, 2012; Barseghyan et al., 2011; Blais and Weber, 2006; Bleichrodt and Johannesson, 2001; Bleichrodt et al., 1997; Butler et al., 2012; Cairns, 1994; Chapman, 1996; Chapman and Elstein, 1995; Cubitt and Read, 2007; Einav et al., 2010; Finucane et al., 2000; Galizzi et al., 2016; Hanoch et al., 2006; Hardisty and Weber, 2009; Hershey and Schoemaker, 1980; Jackson et al., 1972; MacCrimmon and Wehrung, 1990; Prosser and Wittenberg, 2007; Viscusi and Evans, 1990; Weber et al., 2002). Even within the same health domain, preferences vary across different contexts (Bradford et al., 2014; Butler et al., 2012; Harrison et al., 2005a; Szrek et al., 2012; van der Pol and Ruggeri, 2008). It is possible, therefore, that doctors' and patients' healthcare decisions are explained not only by their risk and time preferences for monetary outcomes, but also (and perhaps more closely) by risk and time preferences for healthcare outcomes. No secondary data, however, currently exist that directly elicit health-related risk and time preferences for patients and doctors (Bradford, 2010).

In this article we attempt to fill this gap by explicitly investigating whether patients and their matched doctors in natural clinical settings have similar risk and time preferences for healthcare outcomes. As a robustness check, we also measure risk and time preferences in a closely comparable financial context. To the best of our knowledge, ours is the first attempt to systematically look at differences and similarities of risk and time preferences across doctors and patients in a real healthcare setting.

We conduct a 'framed field experiment' based on Harrison and List (2004) (an 'extra-lab' experiment according to Charness et al., 2013b). Field experiments are increasingly employed in exploring preferences (Andersen et al., 2008a, 2008b, 2014; Charness et al., 2013a; Harrison et al., 2007; Sutter et al., 2011), and in comparing them across different groups of subjects (Croson and Gneezy, 2009; Harrison et al., 2009; Masclet et al., 2009). In our field experiment we measure patients' and doctors' risk and time preferences by adapting the multiple price list (MPL) tests proposed by Holt and Laury (2002) and Tanaka et al. (2010), respectively, to the healthcare context (Galizzi et al., 2016). In order to address any issue that can potentially arise from framing and domain-specificity in preference elicitation, we also measure patients' and doctors' risk and time preferences using the same MPL tests but in a closely comparable financial context.

We have three main results. First, there is a significant difference in time preferences between patients and their matched doctors, with doctors discounting future health gains and financial outcomes less heavily than patients. Second, we find no systematic difference in risk preferences in the healthcare domain between patients and doctors: in our sample both patients and their matched doctors are mildly, but significantly, risk averse. Third, doctors and patients have significantly different risk preferences in the finance domain: whilst doctors are risk averse, patients are risk neutral.

The rest of the article is organised as follows. Section 2 contains a brief description of the methods whilst Section 3 reports the main results. Section 4 discusses the main findings in the context of the literature, whilst the last section briefly concludes.

## 2. Methods

### 2.1. Study design

We conducted a field experiment among patients and doctors in a university hospital in Athens (Laiko Hospital), Greece, in four waves between September 2010 and November 2011.[1] Patients were asked to complete a questionnaire (Online Appendix A1) whilst they were waiting in the outpatients' clinics to see their doctors. The questionnaire was completed in the presence of a research assistant who explained the questions and was available for assistance during the completion of the questionnaire. The patients' doctors were also invited to take part in the study by completing a similar questionnaire. The outpatient clinics were pathology, cardiology, gynaecology, haematology, surgery, endocrinology, orthopaedics, urology, gastroenterology, nephrology, rheumatology, ophthalmology, and otolaryngology. Patients who attend the outpatient clinics are seen by the first available doctor. They are therefore randomly assigned to their doctors. We obtained questionnaire data for 300 patients and 67 doctors. Not all patients could be matched to the doctor they saw for two reasons. First, patients did not know beforehand which doctor they would see, and some patients refused to answer further questions when leaving the clinic. Second, some doctors did not complete the questionnaire. A total of 144 patients (48% of patients) could be matched to their doctors.

The study was approved by the hospital's Research Ethics Board on 6 August 2010 (protocol number ES 462).

### 2.2. Questionnaire and variables

The questionnaire included a number of socio-demographic questions, such as the respondents' age (*Age*), gender (*Female*), marital status (*Married*), education level (*Educ*), perception of their current financial situation (*FinConstr*), and whether they have children or not (*Children*). Patients were also asked about their health status, both by reporting their self-assessed health (*SAH*) and whether or not they had a chronic condition (*Chronic*). A full description of the variables in the questionnaire can be found in Appendix A.

#### 2.2.1. Risk preferences

Risk preferences were measured using an adaptation of the Holt and Laury (2002) MPL test to the healthcare context (Galizzi et al., 2016). The MPL method is one of the most widely used incentive-compatible tests in experimental economics to measure risk preferences for monetary outcomes (Charness et al., 2013a). Subjects are presented with a series of choices between two lotteries (A and B). The payoffs in the lotteries remain constant but the probability associated with each payoff changes. Lottery A is associated with a higher expected pay-off in the first few choices but this switches to lottery B in the later choices.

The MPL was adapted by presenting the lotteries as different healthcare treatments with payoffs defined as days of full health (Table 1). A risk-neutral individual should switch from the 'safe'

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[1] Round 1 of data collection started in September 2010, lasted 5 weeks and included 91 patients. Round 2 started in January 2011, lasted 4 weeks and included 34 patients. Round 3 started in April 2011, lasted 5 weeks and included 56 patients. Round 4 started in October 2011, lasted 4 weeks and included 119 patients. It should be noted that the survey was conducted at a time of great economic crisis. The potential implications are discussed in detail in Galizzi et al. (2016).

**Table 1**
Adaptation of the Holt and Laury (2002) MPL test to measure risk preferences in the healthcare domain.

| ID | Treatment A | | | | Treatment B | | | | Your Choice | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P | Days in full health | P | Days in full health | P | Days in full health | P | Days in full health | A | B |
| 1 | 10% | 200 | 90% | 160 | 10% | 385 | 90% | 10 | A | B |
| 2 | 20% | 200 | 80% | 160 | 20% | 385 | 80% | 10 | A | B |
| 3 | 30% | 200 | 70% | 160 | 30% | 385 | 70% | 10 | A | B |
| 4 | 40% | 200 | 60% | 160 | 40% | 385 | 60% | 10 | A | B |
| 5 | 50% | 200 | 50% | 160 | 50% | 385 | 50% | 10 | A | B |
| 6 | 60% | 200 | 40% | 160 | 60% | 385 | 40% | 10 | A | B |
| 7 | 70% | 200 | 30% | 160 | 70% | 385 | 30% | 10 | A | B |
| 8 | 80% | 200 | 20% | 160 | 80% | 385 | 20% | 10 | A | B |
| 9 | 90% | 200 | 10% | 160 | 90% | 385 | 10% | 10 | A | B |

option (treatment A) to the ‘risky’ option (treatment B) only when the expected utility is greater in treatment B than in A. An individual who is risk neutral chooses treatment A in rows 1–4, before switching to B in row 5. A risk averse individual switches to treatment B after row 5, whilst a risk lover switches before row 5. Thus, the switching point is a measure of an individual’s risk preferences. We define *SwitchRiskHP* (*SwitchRiskHD*) a variable denoting the point at which a given patient (doctor) switched from lottery A to lottery B. This ranges from 1 (switching to treatment B in the first row) to 10 (never switching to treatment B) and the higher the value, the more risk averse the patient (doctor) is.

### 2.2.2. Time preferences

Time preferences were measured using an adaptation of the Tanaka et al. (2010) MPL to the healthcare context. Subjects were presented with a series of six blocks of choices, each of which had five choices between two different healthcare treatments. Subjects were asked to consider their current health status and to choose between two possible hypothetical treatments, A and B, with different days of full health at different points in time (Table 2). In each block, treatment A gave a larger number of days in full health than treatment B. Treatment A, however, was offered with some delay (so-called *Larger-Later* option, LL) whilst treatment B was always available immediately (so-called *Smaller-Sooner* option, SS). Treatment B offered progressively a larger number of days in full health. The time delay varied between blocks of lotteries from 1 week (blocks 1 and 4) to 1 month (blocks 2 and 5), to 3 months (blocks 3 and 6). We used switching points as simple measures of individual time preferences. The later individuals switch from treatment A to treatment B the more patient they are. The variable *SwitchTimeHPBi* (*SwitchTimeHDBi*) denotes the specific point at which a given patient (doctor) switched from option A to option B in the block of questions *i*. The values range from 1 to 6 and the higher the value, the more patient the subject is.

## 2.3. Analysis

We examine differences in risk and time preferences between patients and doctors using two measures for individual preferences. First, we examine switching points in the MPL tests as indicators of individual risk and time preferences. The higher the value of the *SwitchRiskHP* (*SwitchRiskHD*) variable, the more risk

**Table 2**
Adaptation of the Tanaka et al. (2010) test to measure time preferences in the healthcare domain.

| ID | Treatment A | Treatment B | Your choice | |
|---|---|---|---|---|
| 1.1 | 360 days in full health starting in 1 week | 60 days in full health starting today | A | B |
| 1.2 | 360 days in full health starting in 1 week | 120 days in full health starting today | A | B |
| 1.3 | 360 days in full health starting in 1 week | 180 days in full health starting today | A | B |
| 1.4 | 360 days in full health starting in 1 week | 240 days in full health starting today | A | B |
| 1.5 | 360 days in full health starting in 1 week | 300 days in full health starting today | A | B |
| 2.1 | 360 days in full health starting in 1 month | 60 days in full health starting today | A | B |
| 2.2 | 360 days in full health starting in 1 month | 120 days in full health starting today | A | B |
| 2.3 | 360 days in full health starting in 1 month | 180 days in full health starting today | A | B |
| 2.4 | 360 days in full health starting in 1 month | 240 days in full health starting today | A | B |
| 2.5 | 360 days in full health starting in 1 month | 300 days in full health starting today | A | B |
| 3.1 | 360 days in full health starting in 3 months | 60 days in full health starting today | A | B |
| 3.2 | 360 days in full health starting in 3 months | 120 days in full health starting today | A | B |
| 3.3 | 360 days in full health starting in 3 months | 180 days in full health starting today | A | B |
| 3.4 | 360 days in full health starting in 3 months | 240 days in full health starting today | A | B |
| 3.5 | 360 days in full health starting in 3 months | 300 days in full health starting today | A | B |
| 4.1 | 900 days in full health starting in 1 week | 150 days in full health starting today | A | B |
| 4.2 | 900 days in full health starting in 1 week | 300 days in full health starting today | A | B |
| 4.3 | 900 days in full health starting in 1 week | 450 days in full health starting today | A | B |
| 4.4 | 900 days in full health starting in 1 week | 600 days in full health starting today | A | B |
| 4.5 | 900 days in full health starting in 1 week | 750 days in full health starting today | A | B |
| 5.1 | 900 days in full health starting in 1 month | 150 days in full health starting today | A | B |
| 5.2 | 900 days in full health starting in 1 month | 300 days in full health starting today | A | B |
| 5.3 | 900 days in full health starting in 1 month | 450 days in full starting health today | A | B |
| 5.4 | 900 days in full health starting in 1 month | 600 days in full health starting today | A | B |
| 5.5 | 900 days in full health starting in 1 month | 750 days in full health starting today | A | B |
| 6.1 | 900 days in full health starting in 3 months | 150 days in full health starting today | A | B |
| 6.2 | 900 days in full health starting in 3 months | 300 days in full health starting today | A | B |
| 6.3 | 900 days in full health starting in 3 months | 450 days in full health starting today | A | B |
| 6.4 | 900 days in full health starting in 3 months | 600 days in full health starting today | A | B |
| 6.5 | 900 days in full health starting in 3 months | 750 days in full health starting today | A | B |

averse in healthcare a patient (doctor) is. Similarly, the higher the value of the *SwitchTimeHPBi* (*SwitchTimeHDBi*) variable the more patient in healthcare a patient (doctor) is. The Shapiro–Wilk test for normality rejects the null hypothesis that the switching points are normally distributed and we therefore test for differences in means between patients and doctors using the non-parametric (Wilcoxon) Mann–Whitney test. Even though doctors and patients may on average differ in their time and risk preferences, it could be the case that there is no difference in preferences in matched doctor–patient pairs and vice versa. It is therefore important to examine the difference in matched pairs as well as the difference in overall mean between doctors and patients. This is done by examining the number of patients who have identical or similar switching points to their doctors. We test for differences in switching points in matched pairs using the Wilcoxon matched-pairs signed-ranks test. As mentioned previously, 48% of patients can be matched to their doctor. Statistical tests (chi-square and t-tests) show that this sub-sample is similar to the whole sample in terms of socio-demographic characteristics.

Second, we 'structurally' estimate the behavioural parameters within the utility functions. We separately estimate risk and time preferences following the empirical approaches by Harrison and Rutström (2008a), Andersen et al. (2010), and Tanaka et al. (2010). We assume that the health-related risk preferences can be represented by a constant relative risk aversion (CRRA) utility function. The utility function of a subject in terms of healthcare payoffs $x$, is thus represented by

$$U(x)=\frac{x^{1-s}}{1-s} \tag{1}$$

where $s$ is the coefficient of constant relative risk aversion in the healthcare context. Depending on the value of $s$ a subject shows different degrees of risk aversion in the healthcare domain that can be grouped in three main types:

1. if $s=0$ risk neutral
2. if $s>0$ risk averse
3. if $s<0$ risk seeking

Maximum Likelihood (ML) methods were used to empirically estimate risk preferences (Harrison and Rutström, 2008a and Andersen et al., 2010). From Equation (1) $U(x)$ is the utility that a subject perceives from getting a healthcare benefit $x$. Under Expected Utility Theory, the expected utility by a subject of a given lottery $j=A,B$ is the utility of each outcome $k=1,2$ in that lottery, weighted by the probability $p_k$ of the outcome:

$$EU_j=\sum\nolimits_{k=1,2} p_{kj} * U(x_{kj}) \tag{2}$$

with $j=A,B$ and $k=1,2$. The expected utility depends on the subject's risk aversion parameter $s$. Based on a candidate value of $s$ a latent preference index $\Delta(EU)$ can be constructed. Our empirical model allows subjects in the outpatient clinics to make stochastic errors when comparing expected utilities. We include in our estimation a parameter $\mu$ to capture the stochastic error, so that the latent index is:

$$\Delta(EU)=\frac{(EU_A)^{1/\mu}}{(EU_A)^{1/\mu}+(EU_B)^{1/\mu}} \tag{3}$$

When $\mu \to 0$ the stochastic errors become negligible and the empirical specification reduces to a deterministic EUT choice, where the subject always chooses the lottery with higher perceived expected utility. When, however, $\mu$ gets larger, $\mu \to \pm\infty$, the choice between the two lotteries becomes essentially random, with the value of the latent index function approaching 1/2 for any values of the expected utilities. We assume that the latent index $\Delta(EU)$ follows a logistic cumulative density function (CDF) taking values between 0 and 1, so that $\Lambda(\Delta(EU))$ can be thought to link the latent preferences and the binary choices observed in the experiment (1):

$$Prob(choosing\ lottery\ A)=\Lambda(\Delta(EU)) \tag{4}$$

Under the assumptions of Expected Utility Theory and of *CRRA* utility functions, the likelihood of observing a specific choice depends on the individual risk preference $s$, given the logistic *CDF* linking the latent index to the observed choices. The individual log-likelihood of choosing either lottery in each of the observed choices $C_i$, in our experiment is given by:

$$Ln\,L(s,\mu;C)=\sum\nolimits_i((ln\,\Lambda(\Delta(EU))|C_i=1)+((ln\,\Lambda(1-\Delta(EU))|C_i=0) \tag{5}$$

where $C_i=1(0)$ denotes the choice of lottery $A(B)$ in the proposed pair of lotteries **i**. The ML was adjusted to allow the *CRRA* parameter $s$ to be a linear function $s=s_0+s_1\,D$ where $D$ is a dummy variable taking value 1 for doctors and 0 for patients.

For time preferences we follow the procedure by Tanaka et al. (2010) to estimate the shape of the discounting function for patients and doctors. Tanaka et al. (2010) use a general discounting model originally proposed by Benhabib et al. (2010) which allows to test exponential, hyperbolic, and quasi-hyperbolic discounting as 'nested' cases of a more general discounting function. The discounting model assigns to a healthcare benefit $y$ at time $t>0$ a value of

$$y\beta(1-(1-\theta)rt)^{1/(1-\theta)} \tag{6}$$

(and a value $y$ for immediate healthcare benefit at $t=0$). The three factors $r$, $\beta$, and $\theta$ identify the levels of baseline time discounting ($r$), present bias ($\beta$), and hyperbolicity of the discounting function ($\theta$), respectively.

This general discounting model nests the three most common discounting specifications as special cases. In particular, when $\beta=1$ as $\theta \to 1$ the discounted value reduces to the conventional exponential discounting model in the limit, $e^{-rt}$ (Samuelson, 1947). When $\beta=1$ as $\theta=2$ the discounted value reduced to the 'pure hyperbolic' discounting model, $\left(\frac{1}{1+rt}\right)$ (Loewenstein and Prelec, 1992).[2] When, finally, $\theta \to 1$ and $\beta$ is a free parameter, then the discounted value reduces to the 'quasi-hyperbolic' or 'present bias' discounting model $\beta e^{-rt}$ (Laibson, 1997; Phelps and Pollak, 1968).

We denote the probability of choosing immediate reward of $x$ over the delayed reward of $y$ in $t$ days by $P(x>(y,t))$ and use a logistic function to describe this relationship (7):

$$P(x>(y,t))=\frac{1}{1+\exp\left(-\mu\left(x-y\beta(1-(1-\theta)rt)^{1/1-\theta}\right)\right)} \tag{7}$$

where $r$,$\beta$,$\theta$ are the above defined parameters, and $\mu$ is a response sensitivity or 'noise' parameter.

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[2] The 'hyperbolic' model originally proposed by Loewenstein and Prelec (1992) actually takes the more general form where the parameter $h$ can be interpreted as a measure of 'decreasing impatience' (Attema et al., 2010; Bleichrodt et al., 2014; Prelec, 2004; Rohde, 2010). When $h=0$, the hyperbolic discounting is equivalent to exponential discounting. The higher the $h$, the more individual discounting deviates from constant discounting. The Loewenstein and Prelec (1992) general hyperbolic model nests further specific models such as the 'power' discounting model when $h=1$ (Harvey, 1986, 1995), and the 'proportional' discounting model when $h=r$ (Mazur, 1987), which is the 'pure hyperbolic' specification fitted in our estimations.

A dummy variable for doctors is included in the models to examine whether parameters vary across doctors and patients. For example, for the 'present bias' model, we fit a logistic function (8)

$$P(x>(y,t))=\frac{1}{1+\exp(-\mu(x-y\beta e^{-rt}))} \tag{8}$$

where $\beta=\beta_0+\beta_1 D$, $r=r_0+r_1 D$, and $D$ is a dummy variable taking value 1 for doctors and 0 for patients.

All estimates were obtained using an iterative nonlinear least square regression procedure with standard errors clustered at individual level, and a minimum number of 100 iterations at 99 percent significance level. When initial values had to be specified in order to help convergence of estimations, multiple replications were performed using a range of different initial values.

### 2.3.1. *Robustness checks and further analysis*

Both the time and risk preference tasks were conducted from the perspective of the subject's current health status. This raises two issues. First, the size of the health gain from the treatment varies across subjects depending on the level of their current health. The health gain is likely to be larger on average for patients compared to their doctors. Earlier empirical evidence suggests that individuals tend to be more risk averse for larger gains although this is now being debated (Harrison et al., 2005b; Holt and Laury, 2002, 2005). If true, this may bias the results towards patients being more risk averse. The time preference literature suggests that individuals discount larger gains at a lower rate than smaller gains (Andersen et al., 2013; Benzion et al., 1989; Chapman and Elstein, 1995; Green et al., 1997; Kirby and MarakoviĆ, 1996; Scholten and Read, 2010; Thaler, 1981). This may bias the results towards patients being more patient. To explore this we examine whether switching points are a function of self-assessed health using both a chi-square test and a Pearson correlation coefficient. The estimated difference between doctors and patients is less likely to be biased by differences in health gains if there is no statistically significant relationship between self-assessed health and switching point. If there is a significant relationship the sign of the correlation will indicate the direction in which the results may be biased.

Secondly, the use of current health state raises the issue of satiation in subjects who are in full health. Individuals may express indifference (zero time preference and risk neutrality) in that case or not engage with the tasks. We explore this by replicating the analysis excluding subjects who reported to be in full health.

To further test the robustness of our results, we also compare time and risk preferences between patients and doctors in the finance domain using the Tanaka et al. (2010) MPL test and the Holt and Laury (2002) MPL test (Online Appendix A2). In the financial domain, the size of the gain is the same across all subjects and none of the subjects will be satiated. Whilst time and risk preferences have been shown to be domain specific (Attema, 2012; Barseghyan et al., 2011; Blais and Weber, 2006; Bleichrodt and Johannesson, 2001; Bleichrodt et al., 1997; Butler et al., 2012; Cairns, 1994; Chapman, 1996; Chapman and Elstein, 1995; Cubitt and Read, 2007; Einav et al., 2010; Finucane et al., 2000; Galizzi et al., 2016; Hanoch et al., 2006; Hardisty and Weber, 2009; Hershey and Schoemaker, 1980; Jackson et al., 1972; MacCrimmon and Wehrung, 1990; Prosser and Wittenberg, 2007; Viscusi and Evans, 1990; Weber et al., 2002), it could be argued that, if the domain effect is similar across patients and doctors, then the *difference* in preferences between doctors and patients should be similar across domains. Similar differences across the two domains would increase the confidence we can place on the healthcare results.

## 3. Results

### 3.1. *Summary statistics*

The summary statistics for the two samples of patients and doctors are reported in Table 3. Due to missing values the sample size for estimating time and risk preferences varies from 241 to 294 for patients and from 56 to 66 for doctors. The four patients who switched back in the time preference tasks were omitted from the analysis.

The statistics show that, with the exceptions of income (and education) levels, age, and self-assessed health, doctors and patients in our sample have comparable socio-demographic characteristics.

**Table 3**
Descriptive statistics.

| Variable | N | Mean | Std. Dev. | Min | Max | N | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| | Patients | | | | | Doctors | | | | |
| *SwitchHRisk* | 281 | 5.06 | 2.57 | 0 | 10 | 58 | 5.03 | 2.05 | 1 | 10 |
| *SwitchHTimeB1* | 273 | 4.39 | 1.93 | 1 | 6 | 63 | 4.88 | 1.69 | 1 | 6 |
| *SwitchHTimeB2* | 265 | 3.35 | 2.03 | 1 | 6 | 60 | 4.2 | 1.93 | 1 | 6 |
| *SwitchHTimeB3* | 252 | 2.68 | 2.02 | 1 | 6 | 61 | 3.52 | 1.98 | 1 | 6 |
| *SwitchHTimeB4* | 248 | 4.63 | 1.89 | 1 | 6 | 60 | 4.8 | 1.91 | 1 | 6 |
| *SwitchHTimeB5* | 242 | 3.41 | 2.01 | 1 | 6 | 56 | 4.12 | 2.15 | 1 | 6 |
| *SwitchHTimeB6* | 241 | 2.81 | 2.03 | 1 | 6 | 56 | 3.8 | 2.14 | 1 | 6 |
| *SwitchFRisk* | 294 | 4.90 | 2.75 | 1 | 10 | 59 | 5.52 | 2.36 | 1 | 10 |
| *SwitchFTimeB1* | 294 | 4.12 | 1.98 | 1 | 6 | 66 | 4.77 | 1.65 | 1 | 6 |
| *SwitchFTimeB2* | 293 | 3.05 | 1.88 | 1 | 6 | 65 | 4.36 | 1.62 | 1 | 6 |
| *SwitchFTimeB3* | 292 | 2.43 | 1.77 | 1 | 6 | 66 | 3.64 | 1.77 | 1 | 6 |
| *SwitchFTimeB4* | 291 | 4.67 | 1.87 | 1 | 6 | 65 | 5.14 | 1.39 | 1 | 6 |
| *SwitchFTimeB5* | 290 | 3.71 | 1.97 | 1 | 6 | 66 | 4.44 | 1.63 | 1 | 6 |
| *SwitchFTimeB6* | 289 | 2.69 | 1.83 | 1 | 6 | 66 | 3.57 | 1.81 | 1 | 6 |
| *Age* | 238 | 39.61 | 12.93 | 18 | 74 | 61 | 36.59 | 8 | 27 | 63 |
| *Female* | 300 | 0.48 | 0.50 | 0 | 1 | 67 | 0.46 | 0.50 | 0 | 1 |
| *Educ* | 238 | 5.59 | 1.63 | 2 | 8 | | | | | |
| *Married* | 300 | 0.34 | 0.47 | 0 | 1 | 67 | 0.38 | 0.49 | 0 | 1 |
| *Children* | 300 | 0.34 | 0.47 | 0 | 1 | 67 | 0.23 | 0.43 | 0 | 1 |
| *FinConstr* | 232 | 2.45 | 0.74 | 1 | 4 | 60 | 2.03 | 0.66 | 1 | 3 |
| *SAH* | 300 | 2.39 | 1.16 | 1 | 5 | 67 | 1.62 | 0.73 | 1 | 4 |
| *Chronic* | 300 | 0.17 | 0.37 | 0 | 1 | | | | | |

**Table 4**
Differences in time preferences between doctors and patients.

| | TimeB1 | TimeB2 | TimeB3 | TimeB4 | TimeB5 | TimeB6 |
|---|---|---|---|---|---|---|
| Healthcare | | | | | | |
| Number of patients | 273 | 265 | 252 | 248 | 242 | 241 |
| Number of doctors | 63 | 60 | 61 | 60 | 56 | 56 |
| Switching point mean patients | 4.39 | 3.35 | 2.68 | 4.63 | 3.41 | 2.81 |
| Switching point mean doctors | 4.88 | 4.2 | 3.52 | 4.8 | 4.1 | 3.80 |
| z statistic | –1.911 | –2.770 | –2.940 | –0.899 | –2.249 | –2.937 |
| p-value | 0.0560 | 0.0056 | 0.0033 | 0.3685 | 0.0245 | 0.0033 |
| Finance | | | | | | |
| Number of patients | 294 | 293 | 292 | 291 | 290 | 289 |
| Number of doctors | 66 | 65 | 66 | 65 | 66 | 66 |
| Switching point mean patients | 4.12 | 3.06 | 2.43 | 4.67 | 3.71 | 2.69 |
| Switching point mean doctors | 4.77 | 4.35 | 3.64 | 5.14 | 4.44 | 3.57 |
| z statistic | –2.343 | –4.941 | –4.985 | –1.457 | –2.555 | –3.558 |
| p-value | 0.0191 | 0.0000 | 0.0000 | 0.1451 | 0.0106 | 0.0004 |

*Note:* P-values refer to tests of the null hypothesis that switching points are not statistically significantly different across patients and doctors.

### 3.2. Switching points measures for risk and time preferences: differences between patients and doctors

We start by examining differences in risk preferences. The mean switching point in the healthcare domain was $\mathit{SwitchHRiskP} = 5.06$ (SD = 2.57) for patients and $\mathit{SwitchHRiskD} = 5.03$ (SD = 2.05) for doctors. The Mann–Whitney test failed to reject the null hypothesis that $\mathit{SwitchHRiskP} = \mathit{SwitchHRiskD}$ ($z = -0.332$, $p = 0.7401$), suggesting that health-related risk preferences are similar for doctors and patients.

The lack of significance of the chi-square test and the Pearson correlation ($p = 0.433$ and $p = 0.0875$ respectively) suggest that there is no significant relationship between risk preferences and self-assessed health. The potential difference in the size of the health gain between doctors and patients is therefore unlikely to have biased the comparison. To further test the robustness of the results we also compare risk preferences in the financial domain. The mean switching point in the finance domain was $\mathit{SwitchFRiskP} = 4.90$ (SD = 2.75) for patients, whilst for the doctors it was $\mathit{SwitchFRiskD} = 5.52$ (SD = 2.36). The Mann–Whitney rejects the null hypothesis that $\mathit{SwitchFRiskP} = \mathit{SwitchFRiskD}$ at a 95% significance level ($z = -1.973$, $p = 0.0485$), suggesting a significant difference in the finance-related risk preferences between the two groups, with the doctors being more risk averse in finance than patients.

In case of time preferences, a relatively large proportion of doctors and patients never switched from option A to option B, with the exact proportion varying per block of questions. In the healthcare domain the percentage of respondents never switching were 50% in the first block, 28% in the second, 19% in the third, 57% in the fourth block, 32% in the fifth and 25% in sixth block. Similar figures hold for the finance domain.

Table 4 shows that in healthcare the mean switching points for doctors are higher across all six blocks of pairwise choices, and the doctor–patient differences are significant in all cases but the fourth block. Note that the doctor–patient differences are only marginally significant in the first block. This suggests that doctors are more patient when discounting future health outcomes than patients, at least for time delays longer than a week. The significance of the chi-square test and the Pearson correlation suggest that there is a significant relationship between time preferences and self-assessed health (p-values for chi-square test range from 0.0001 to 0.1001 across the six blocks, and the p-values for the Pearson correlation range from 0.0000 to 0.0001). The correlation is negative suggesting that larger health gains (lower self-assessed health) are discounted at a higher rate. The difference in time preferences may therefore be caused by the difference in current health status between doctors and patients. To explore this further we also compare time preferences in the financial domain. Table 4 shows that the results for time preferences for money are very similar in that doctors are significantly more patient than their patients.

Table 5 shows the difference in switching points between matched doctor–patient pairs. The proportion of patients who have identical time and risk preferences to their doctor ranges from 19.5% for risk preferences to 38.9% for time preferences (fourth block). Switching points are 2 or more apart from their doctors for around 50% of patients. The results of the Wilcoxon matched pairs test are in line with the results for the aggregate preferences. There are no differences in risk preferences but matched doctor–patients do differ in terms of their time preferences. That the results are similar is perhaps not surprising given that patients in our outpatient clinics were randomly assigned to a doctor.

### 3.3. Structural estimation of risk and time preferences: differences between patients and doctors

Table 6 shows the ML results which allow the fitted parameters to be a function of a doctor dummy variable, in order to estimate differences across the two types of respondents. The estimates for the two subsamples of doctors and patients are reported in Appendix B and are in line with the pooled results. The table also

**Table 5**
Difference in switching point in matched doctor–patient pairs.

| | No difference | | Difference of 1 point | | Difference of more than 1 point | | Wilcoxon matched pairs test |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | p-value |
| SwitchHRisk | 24 | 19.5 | 31 | 25.2 | 68 | 55.3 | 0.1074 |
| SwitchHTimeB1 | 43 | 33.6 | 17 | 13.3 | 68 | 53.1 | 0.0002 |
| SwitchHTimeB2 | 32 | 27.4 | 21 | 17.9 | 64 | 54.7 | 0.0000 |
| SwitchHTimeB3 | 38 | 35.2 | 14 | 13.0 | 56 | 51.9 | 0.0000 |
| SwitchHTimeB4 | 42 | 38.9 | 8 | 7.4 | 58 | 53.7 | 0.0036 |
| SwitchHTimeB5 | 34 | 34.3 | 13 | 13.1 | 52 | 52.5 | 0.0125 |
| SwitchHTimeB6 | 34 | 35.4 | 12 | 12.5 | 50 | 52.1 | 0.0000 |

**Table 6**
Estimated risk aversion parameters under CRRA.

| | Healthcare domain | | Finance domain | |
|---|---|---|---|---|
| s | 0.1415*** | 0.1211** | 0.0432 | –0.0135 |
| | (0.0470) | (0.0522) | (0.0535) | (0.0578) |
| $s^d$ | –0.0138 | 0.0872 | 0.0253 | 0.3352*** |
| | (0.0322) | (0.1092) | (0.0315) | (0.1173) |
| $\mu$ | 30.8911*** | 34.5442*** | 52.3180*** | 71.8444*** |
| | (6.6939) | (8.5517) | (13.4195) | (20.7522) |
| $\mu^d$ | | –14.8975 | | –59.5904*** |
| | | (12.0268) | | (21.5227) |
| Observations | 3051 | 3051 | 3177 | 3177 |
| Log pseudo LL | –1721.87 | –1719.70 | –1771.23 | –1756.73 |

*Notes:* * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$. Sample size in the healthcare domain is 3051: 9 observations for 281 patients and 58 doctors. Sample size in the financial domain is 3177: 9 observations for 294 patients and 59 doctors.
Superscript *d* refers to the doctors' dummy variables.

shows that the doctor dummy variable is not statistically significant in the estimates for the CRRA parameter in the healthcare domain, confirming that there are no systematic differences in risk preferences for healthcare outcomes across doctors and patients. The doctor dummy variable is also not significant in the estimates for the stochastic error $\mu$, suggesting that doctors and patients are equally likely to make errors in their responses to the test. In the finance domain, the doctors' dummy variable is significantly associated with both the CRRA and the noise coefficient: doctors are more risk averse in finance than patients, and also make fewer errors in their choices compared to patients.

As for time preferences, due to the relatively small number of observations for the doctors, we were unable to reliably fit the general discounting model. We therefore focus on the estimation of the three 'nested' discounting models: (i) the 'exponential' model; (ii) the 'pure' hyperbolic discounting model; and (iii) the 'quasi-hyperbolic' or 'present bias' model. Table 7 shows the results for the three different discounting models.[3] In the healthcare domain, the estimated coefficient for the doctor dummy variable is negative and highly significant in both the 'exponential' and the 'pure hyperbolic' model (–0.015, with $SE = 0.0036$, and –0.0248 with $SE = 0.0064$, respectively), suggesting that doctors are less impatient than patients. The estimated coefficient for the doctor dummy variable is also negative and highly significant in the finance domain (–0.0135, with $SE = 0.0025$, in the 'exponential' model, and –0.0237, with $SE = 0.0047$, in the 'pure hyperbolic' model). In the 'present bias' model, the doctor dummy variable is negative and highly significant for the long-run discounting rates (–0.0159, with $SE = 0.0034$, in the healthcare domain; and –0.0096, with $SE = 0.0020$, in the finance domain), but does not reach statistical significance for the present bias parameter (0.0144, with $SE = 0.1126$, in the healthcare domain, and 0.1033, with $SE = 0.0813$, in the finance domain). Estimates also confirm that doctors are generally less impatient than patients, and that, the present bias parameter is not significantly different from one.

The goodness of fit of the estimated discounting models is relatively high with the adjusted $R^2$ ranging from 0.5243 to 0.5301 in the healthcare domain, and from 0.5690 to 0.5706 in the finance domain. The goodness of fit does not vary substantially across the different specifications within the same domain.

The above estimates of the risk and time preferences parameters and of the doctor–patient dummy are robust to the introduction in the models of further covariates, such as gender, age, financial state, and self-assessed health. Finally, similar results were found when excluding subjects who reported to be in full health suggesting that satiation might not have been an issue (results available upon request).

## 4. Discussion

Our data suggest that there is no systematic difference in risk preferences in the healthcare domain between doctors and patients: both doctors and patients tend to be mildly risk averse in the healthcare domain. It could be argued that the lack of significant doctor–patient differences in risk preferences in health is not due to a genuine similarity of the underlying risk preferences, but is partly an artefact of the differences in perceived health gains with doctors closer to being 'satiated' in health than patients.[4] On average, doctors' self-reported health was higher than patients (1.62 compared to 2.39). However, we found no significant relationship between risk preferences and self-assessed health. This is in line with other studies which have questioned the earlier evidence that individuals tend to be more risk averse for larger (monetary) outcomes (Harrison et al., 2005b; Holt and Laury, 2002, 2005). If the earlier evidence holds, this would imply that doctors would be *more* risk averse if presented with larger health gains. Therefore, the non-significant small difference in risk aversion in healthcare between patients and doctors found in our estimations may have resulted from an *underestimation* of risk aversion in doctors.

The use of current health state as the reference point also raises the question as to how subjects in good health answered the questions as they were 'satiated' in their level of health. Around half of the doctors (51.25%) reported to be in very good health. However, excluding subjects who reported to be in very good health did not change the results. Given that all subjects gave reasonable and meaningful answers all throughout the tests, and that the estimates of the CRRA coefficient are consistent with non-satiation (e.g. Harrison and Rutström, 2008b, p. 181), it may be the case that subjects who reported being in very good health used a reference health status worse than the self-reported health at the time they participated in the experiment. That is, subjects may have made sense of the scenario presented in a way more consistent with the life-time health losses they experienced or expected to experience. Therefore it is possible that their answers were implicitly anchored to a poorer health status than their reported self-assessed health.

We also compared risk preferences across doctors and patients in the financial domain as a further robustness check. In the financial domain, the size of the gain was the same across all subjects and none of the subjects were satiated. However, it should be noted

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[3] Sample size in Table 7 differs across the healthcare and the finance domains due to different missing data in the different blocks of time preferences questions. In the healthcare domain, 273 patients and 63 doctors answered the first block of questions; 265 patients and 60 doctors answered the second block of questions; 252 patients and 61 doctors answered the third block of questions; 248 patients and 60 doctors answered the fourth block of questions; 242 patients and 56 doctors answered the fifth block of questions; and 241 patients and 56 doctors answered the last block of questions. Since each block had five time preferences questions, this gives a total of 9385 responses in the healthcare domain. Similarly, in the financial domain, 294 patients and 66 doctors answered the first block of questions; 293 patients and 65 doctors answered the second block of questions; 292 patients and 66 doctors answered the third block of questions; 291 patients and 65 doctors answered the fourth block of questions; 290 patients and 66 doctors answered the fifth block of questions; and 289 patients and 66 doctors answered the last block of questions. This gives a total of 10,715 responses in the finance domain.

[4] Note that we have opted for having the same framing across patients and doctors in order to not confound the findings with differences in the framing. An alternative experiment design could consist of presenting both doctors and patients with the same baseline hypothetical health status scenario. Given the non-observable differences in health status across patients, however, it would not be possible to elicit which health status (whether their own status or the hypothetical baseline status) was more salient in patients' choices. It is plausible to presume that the most salient would be the most severe health status, implying that a patient with a cancer diagnosis would anchor her choices to her real health status, whereas a doctor in full health would be more likely to anchor his choices to the hypothetical baseline scenario.

**Table 7**
Estimated discounting parameters under exponential, hyperbolic, and quasi-hyperbolic discounting models.

| | Healthcare domain | | | Finance domain | | |
|---|---|---|---|---|---|---|
| | Exponential | Hyperbolic | Quasi-hyperbolic | Exponential | Hyperbolic | Quasi-hyperbolic |
| μ | 0.0037$^{***}$ | 0.0042$^{***}$ | 0.0035$^{***}$ | 0.0045$^{***}$ | 0.0051$^{***}$ | 0.0048$^{***}$ |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0003) | (0.0003) |
| r | 0.0215$^{***}$ | 0.0338$^{***}$ | 0.0231$^{***}$ | 0.0208$^{***}$ | 0.0339$^{***}$ | 0.0171$^{***}$ |
| | (0.0029) | (0.0055) | (0.0031) | (0.0021) | (0.004) | (0.0017) |
| b | | | 1.0404$^{***}$ | | | 0.8997$^{***}$ |
| | | | (0.0611) | | | (0.0813) |
| $r^d$ | −0.015$^{***}$ | −0.0248$^{**}$ | −0.0159$^{***}$ | −0.0135$^{***}$ | −0.0237$^{***}$ | −0.0096$^{***}$ |
| | (0.0036) | (0.0064) | (0.0034) | (0.0025) | (0.0047) | (0.0020) |
| $b^d$ | | | 0.0144 | | | 0.1033 |
| | | | (0.1126) | | | (0.0813) |
| Observations | 9,385 | 9,385 | 9,385 | 10,715 | 10,715 | 10,715 |
| Adj R-squared | 0.5300 | 0.5243 | 0.5301 | 0.5690 | 0.5706 | 0.5697 |

*Notes:* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}p < 0.01$. Sample size differs across the healthcare and the finance domains due to different missing data in the different blocks of the time preferences questions. See footnote 4 for a detailed explanation.
Superscript *d* refers to the doctors' dummy variables.

that doctors in our sample are generally on higher incomes than their patients, and income is known to be associated with risk preferences (Donkers et al., 2001). Doctors and patients did significantly differ in their risk preferences in the finance domain, with doctors being risk averse whilst patients are risk neutral. Moreover, the estimated CRRA coefficient for doctors in finance is higher than their CRRA coefficient in health (Appendix B), suggesting that the differences in risk preferences across doctors and patients may have been underestimated in the healthcare domain. An alternative explanation for the difference in risk preferences in the monetary domain is the difference in income levels.

In case of time preferences, our evidence suggests that doctors are more patient than their patients when deciding over healthcare treatments with benefits at different points in time. We do not find any support for present bias either in patients' or in doctors' time preferences for healthcare treatments. The above results are confirmed for the financial domain. We found a significant relationship between time preferences and self-assessed health with larger health gains being discounted at a higher rate. The difference in time preferences between doctors and patients may have therefore in part been caused by differences in the size of the health gain. However, we found a similar difference in time preferences between doctors and patients across the two domains.

For the health domain, the lack of present bias is in line with other recent studies which, using different methods, also reject the quasi-hyperbolic model for time preferences in health (Bleichrodt et al., 2014), but it is in contrast with earlier evidence on quasi-hyperbolic discounting for health outcomes (Cairns and Van der Pol, 1997; van der Pol and Cairns, 2002). For the finance domain, our findings may seem unexpected given the widespread support in favour of quasi-hyperbolic discounting among behavioural economists (Ainslie, 1975; Angeletos et al., 2001; DellaVigna and Malmendier, 2006; Diamond and Köszegi, 2003; Gruber and Köszegi, 2001, 2004; Kirby and Maraković, 1995; Kirby et al., 1999; Laibson, 1997; Loewenstein and Prelec, 1992; McClure et al., 2004; O'Donoghue and Rabin, 1999; Phelps and Pollak, 1968; Strotz, 1955; Thaler, 1981).

A number of reasons can explain the differences in findings, including the hypothetical rewards, the elicitation method, the subject pool, and the study setting. More generally, some recent experimental results on time preferences over monetary outcomes suggest that the evidence on hyperbolic discounting is not unanimous. For instance, a number of recent studies have failed to support the hypothesis of non-constant discounting, including Andreoni and Sprenger (2012), Laury et al. (2012), and Andersen et al. (2014). Furthermore, a review of the literature by Andersen et al. (2014) notices that all evidence to date on non-constant discounting with monetary outcomes refers either to hypothetical surveys, or to studies with no incentive-compatible rewards, or to lab experiments with student subjects. None of the studies included in the review by Andersen et al. (2014) elicits hypothetical health- and finance-related time preferences from doctors and patients in real clinical settings.

Our study adds to this evidence and, to the best of our knowledge, is the first study to suggest that patients and doctors in real clinical settings may not exhibit any significant present bias when making decisions on healthcare treatments over time. Given that quasi-hyperbolic discounting is associated to dynamic inconsistency, it is somehow reassuring to learn that, at least when it comes to healthcare decisions in real clinical settings, not only doctors but also patients exhibit time-consistent preferences. Similarly reassuring is the finding that there is no systematic difference in risk preferences between doctors and patients whey they make decisions over risky healthcare treatments. However, further evidence is needed to understand whether this is due to the specific healthcare domain, the clinical setting, the hypothetical nature of the decisions, or any other specific characteristics of our field study.

## 5. Conclusions

Preferences for risk and time are fundamental individual characteristics that have been found to be associated with numerous health and healthcare behaviours, including: heavy drinking (Anderson and Mellor, 2008; Bradford et al., 2014; Szrek et al., 2012), drink and driving (Sloan et al., 2014) smoking (Barsky et al., 1995; Bradford et al., 2014; Bradford, 2010; Burks et al., 2012; Dohmen et al., 2011; Goto et al., 2009), BMI (Borghans and Golsteyn, 2006; Chabris et al., 2008; Ikeda et al., 2010; Sutter et al., 2013; Weller et al., 2008), poor nutritional quality (Galizzi and Miraldo, 2012); as well as overall self-assessed health (Van Der Pol, 2011), the uptake of vaccinations, preventive care, and medical tests (Axon et al., 2009; Bradford, 2010; Bradford et al., 2010; Chapman and Coups, 1999; Picone et al., 2004) and adherence to treatments (Brandt and Dickinson, 2013; Chapman et al., 2001).

Surprisingly little attention has been paid to differences and similarities of risk and time preferences between doctors and their patients. These differences can potentially have a major impact on doctor–patient communication, healthcare decision-making, and treatment adherence. To the best of our knowledge, ours is the first field experiment to examine differences in risk and time preferences between doctors and patients in real clinical settings.

We have three main findings. First, there is a significant difference in time preferences across patients and their matched doctors, with doctors discounting future less heavily than patients. Second, we find no systematic difference in risk preferences in the healthcare context between patients and doctors: in our sample both patients and their matched doctors are mildly, but significantly, risk averse in the healthcare domain. Third, patients and doctors have significantly different risk preferences in the finance domain: whilst doctors are risk averse, patients are risk neutral. This raises the question whether the healthcare results were biased due to differences in the size of health gain. However, no relationship was found between risk preferences and self-assessed health.

The findings have potential implications for health policy. In several healthcare contexts individuals are matched to their doctors and healthcare on characteristics such as gender and ethnicity (Cooper et al., 2003; Cooper-Patrick et al., 1999; Saha et al., 1999). A number of other interventions have been suggested to improve risk communication during the consultation with the aim of achieving better outcomes (Edwards et al., 2008; Fagerlin et al., 2011). Our research contributes to this line of research suggesting that the doctor–patient matching and communication could be more systematically informed by a broader set of characteristics, such as individual preferences for risk and time. As agents to their patients, doctors, for instance, should attempt to find out more about their patients' risk and time preferences when recommending specific healthcare treatments. Time and risk preferences are difficult to observe but are known to be associated with a number of more observable characteristics such as age, gender and income. One approach is therefore for the doctor to use these observable proxies of time and risk preferences to adjust their treatment recommendations. Given the availability of short questions on self-reported time and risk attitudes, it may also be possible for the doctor to obtain proxy indicators of their patients' preferences (Dohmen et al., 2011; Vischer et al., 2013). Perhaps a more realistic scenario is to make doctors aware of potential differences in time and risk preferences between themselves and their patients and to recommend that they explicitly discuss the relative weights that patients place on the timing and the risk of treatments. Shared decision making between doctors and patients has been found to associate with better health outcomes (Greenfield et al., 1985).

Our findings on time preferences suggest that doctors, aware that patients are discounting the future more heavily, should recommend treatments which reflect the higher weight placed on shorter term benefits. However, it has also been suggested that individuals may consider their heavy discounting of the future to be undesirable, and that they may wish to overcome their impatience (Becker and Mulligan, 1997). If this is the case, then this raises the question whether there is a role for the agent (doctor) to help the patients overcome their impatience for receiving the benefits from treatment.

The study is, of course, not without limitations. The experiments were conducted from the perspective of the participants' current health status. Future research should explore whether results are sensitive to the differences in the size of health gain across doctors and patients. Due to the ethics constraints related to approaching patients in hospital clinics, we were unable to conduct experimental tests with real, incentive-compatible rewards in order to measure risk and time preferences in the healthcare domain. It is widely known that individual responses may change when real rewards are at stake (Andersen et al., 2014; Blackburn et al., 1994; Cummings et al., 1995, 1997). In particular, in the finance domain, hypothetical tests are known to elicit less risk averse preferences than incentive-compatible tests (Battalio et al., 1990; Holt and Laury, 2002). The design and implementation of incentive-compatible tests to measure risk and time preferences in the health domain is a challenging but promising area where more work is needed.

Another aspect which deserves explicit investigation is looking at the interaction between risk and time preferences in health. For monetary outcomes, risk and time preferences have been found to closely correlate and interlink (Ahlbrecht and Weber, 1997, 1997; Anderhub et al., 2001; Andersen et al., 2008b; Andreoni and Sprenger, 2012; Chesson and Viscusi, 2000; Coble and Lusk, 2010; Epstein and Zin, 1989a, 1989b; Frederick et al., 2002; Kreps and Porteus, 1978, 1978; Laury et al., 2012; Noussair and Wu, 2006; Onay and Öncüler, 2007; Stevenson, 1992, 1992; Weber and Chapman, 2005). The experimental economics literature has in fact developed 'structural estimation' models that jointly estimate risk and time preferences (Andersen et al., 2008b, 2014). A similar avenue is beyond the scope of the present study, but it can be usefully explored by the next generation of incentive-compatible tests for preferences in health.

Furthermore, in our experiment doctors completed a questionnaire, which asked them about their own risk and time preferences, just like patients did. This is consistent with the fact that doctors' own risk and time preferences have been shown to correlate with treatment decisions (Allison et al., 1998; Fiscella et al., 2000; Franks et al., 2000; Holtgrave et al., 1991). Doctors, moreover, may have different risk and time preferences regarding their own health from when they prescribe risky healthcare treatments to their patients (Atanasov et al., 2013; Beisswanger et al., 2003; Garcia-Retamero and Galesic, 2012, 2014). This is an intriguing question, and similar patterns have in fact been documented in other doctor–patient interaction contexts, such as the choice of healthcare treatments in a consultation (Ubel et al., 2011). The question, however, is beyond the direct scope of the present study, and is left for further research.

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## Appendix A

Description of variables

| Variable | Variable description |
|---|---|
| Explanatory variables | |
| Individual characteristics for patients and doctors | |
| *Age* | Age in years |
| *Female* | Female gender (0 = no, 1 = yes) |
| *Educ*[*] | Level of education (1 = primary school…8 = doctoral or post-graduate specialisation degree) |
| *FinConstr* | Constrained by my financial state (1 = living comfortably…4 = find it very difficult) |
| *Married* | Married (0 = no, 1 = yes) |
| *Children* | Having children (0 = no, 1 = yes) |
| *SAH* | Self-assessed health (1 = very good…5 = very bad) |
| *Chronic*[*] | Presence of a chronic condition (0 = no, 1 = yes) |
| Risk variables | |
| *SwitchRiskHP* | Patients' risk aversion in healthcare implied by switching point in the test (1 = extremely risk seeking…10 = extremely risk averse) |
| *SwitchRiskHD* | Doctors' risk aversion in healthcare implied by switching point in the test (1 = extremely risk seeking…10 = extremely risk averse) |
| *SwitchRiskFP* | Patients' risk aversion in finance implied by switching point in the test (1 = extremely risk seeking…10 = extremely risk averse) |

(*continued on next page*)

## Appendix A (*continued*)

| Variable | Variable description |
|---|---|
| *SwitchRiskFD* | Doctors' risk aversion in finance implied by switching point in the test (1 = extremely risk seeking…10 = extremely risk averse) |
| Time variables | |
| *SwitchTimeHPBi* | Patients' time preference in healthcare implied by switching point in block *i = 1…6* (1 = least patient…6 = most patient) |
| *SwitchTimeHDBi* | Doctors' time preference in healthcare implied by switching point in block *i = 1…6* (1 = least patient…6 = most patient) |
| *SwitchTimeFPBi* | Patients' time preference in finance implied by switching point in block *i = 1…6* (1 = least patient…6 = most patient) |
| *SwitchTimeFDBi* | Doctors' time preference in finance implied by switching point in block *i = 1…6* (1 = least patient…6 = most patient) |

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* Information obtained only for patients. In order to be consultants in outpatient clinics, all doctors must have at least one post-graduate medical specialisation.

## Appendix B

*Structural estimations for the two subsamples of doctors and patients*

Table B1 Estimated risk aversion parameters in healthcare under CRRA for patients and doctors.

| | Healthcare domain | | Financial domain | |
|---|---|---|---|---|
| | Patients | Doctors | Patients | Doctors |
| s | 0.1211$^{**}$ | 0.2084$^{**}$ | −0.0135 | 0.3217$^{***}$ |
| | (0.0523) | (0.0966) | (0.0578) | (0.1027) |
| μ | 34.5443$^{***}$ | 19.6467$^{**}$ | 71.8446$^{***}$ | 12.2540$^{**}$ |
| | (8.5544) | (8.5086) | (20.7588) | (5.7425) |
| Observations | 2700 | 603 | 2700 | 603 |
| Log pseudo LL | −1422.77 | −296.93 | −1450.75 | −305.97 |

*Note:* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}p < 0.01$.

Table B2 Estimated discounting parameters in the healthcare domain under exponential, hyperbolic, and quasi-hyperbolic discounting models.

| | Healthcare domain | | | Financial domain | | |
|---|---|---|---|---|---|---|
| | Exponential | Hyperbolic | Quasi-hyperbolic | Exponential | Hyperbolic | Quasi-hyperbolic |
| (2) Patients | | | | | | |
| μ | 0.0036$^{***}$ | 0.0042$^{***}$ | 0.0035$^{***}$ | 0.0044$^{***}$ | 0.0052$^{***}$ | 0.0048$^{***}$ |
| | (0.0002) | (0.0003) | (0.0003) | (0.0003) | (0.0004) | (0.0004) |
| r | 0.0215$^{***}$ | 0.0338$^{***}$ | 0.0233$^{***}$ | 0.0279$^{***}$ | 0.0465$^{***}$ | 0.0225$^{***}$ |
| | (0.0029) | (0.0054) | (0.0031) | (0.0040) | (0.0078) | (0.0033) |
| b | | | 1.0445$^{***}$ | | | 0.8829$^{***}$ |
| | | | (0.0635) | | | (0.0548) |
| Observations | 7605 | 7605 | 7605 | 4255 | 4255 | 4255 |
| Adj R-squared | 0.5525 | 0.5535 | 0.5525 | 0.6290 | 0.6293 | 0.6298 |
| (2) Doctors | | | | | | |
| μ | 0.0038$^{***}$ | 0.0039$^{***}$ | 0.0036$^{***}$ | 0.0055$^{***}$ | 0.0058$^{***}$ | 0.0057$^{***}$ |
| | (0.0006) | (0.0006) | (0.0006) | (0.0009) | (0.0009) | (0.0009) |
| r | 0.0065$^{***}$ | 0.0087$^{**}$ | 0.0071$^{***}$ | 0.0082$^{***}$ | 0.0115$^{***}$ | 0.0077$^{***}$ |
| | (0.0018) | (0.0031) | (0.0017) | (0.0017) | (0.0029) | (0.0015) |
| B | | | 1.0426$^{***}$ | | | 0.9685$^{***}$ |
| | | | (0.1016) | | | (0.0788) |
| Observations | 1780 | 1780 | 1780 | 1405 | 1405 | 1405 |
| Adj R-squared | 0.3878 | 0.3883 | 0.3880 | 0.4313 | 0.4321 | 0.4315 |

*Note:* $^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}p < 0.01$.

## Appendix: Supplementary material

Supplementary data to this article can be found online at doi:10.1016/j.jhealeco.2016.10.001.

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