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How Payment Systems Affect Physicians' Provision Behaviour – An Experimental Investigation☆

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Abstract

Understanding how physicians respond to incentives from payment schemes is a central concern in health economics research. We introduce a controlled laboratory experiment to analyse the influence of incentives from fee-for-service and capitation payments on physicians' supply of medical services. In our experiment, physicians choose quantities of medical services for patients with different states of health. We find that physicians provide significantly more services under fee-for-service than under capitation. Patients are overserved under fee-for-service and underserved under capitation. However, payment incentives are not the only motivation for physicians' quantity choices, as patients' health benefits are of considerable importance as well. We find that patients in need of a high (low) level of medical services receive a larger health benefit under fee-for-service (capitation).

Keywords: Physician payment system, laboratory experiment, incentives, fee-for-service, capitation

JEL-Classification: C91, I11

1. Introduction

A central concern in health economics is to understand the influence of institutions on the behaviour of health care markets. Effects from changing institutions like the payment system during a health care reform are *ex ante* not necessarily known to policy makers and may influence behaviour in an undesired way. Main addressees of reforms on the supply side are physicians whose behaviour is likely to be influenced by the payment system. The theoretical literature highlights

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the different incentives of commonly used physician payment systems like fee-for-service (FFS) or capitation (CAP). Under FFS, physicians are paid for each medical procedure or service dispensed to a patient, whereas under CAP, physicians receive a fixed payment for each patient, irrespective of the quantity of medical services provided. In the former system, there is, in general, an incentive to deliver more care in order to increase own income. On the contrary, incentives from CAP can reduce the provision of health services (e.g., Pauly 1990). Moreover, FFS embeds an incentive to overserve patients, whereas CAP may lead to underprovision of medical services (e.g., Ellis and McGuire 1986, McGuire 2000).

Empirical evidence on the impact of payment schemes on physicians' supply of medical services is mixed. Some studies support physicians' responsiveness to payment incentives (e.g., Croxson et al. 2001, Devlina and Sarma 2008). In particular, physicians seem to provide a higher output in FFS than in CAP schemes (e.g., Gaynor and Gertler 1995). Some studies do not corroborate the strong link between payment method and physician behaviour, however (e.g., Hurley and Labelle 1995, Grytten and Sørensen 2001). Causal inferences on the direction and the strength of an effect are rather difficult, as, for example, many studies vary more than one component of the payment system simultaneously. Moreover, behavioural data is gathered from country-specific institutional settings that are hardly comparable (Gosden et al. 2001).

An empirical method is called for that allows to investigate behaviour in a controlled manner and under *ceteris paribus* conditions—as a complement to field studies and surveys. The experimental economics method provides the requested features and has been used for studying behaviour in a wide range of fields within economics. In areas like industrial organization, public choice and labour economics controlled laboratory experiments became commonplace (Camerer 2003, Plott and Smith 2008). In health economics, laboratory experimentation is rather in its infancy.[1] This is surprising, as Fuchs (2000) already argued ten years ago that incorporating methods of experimental economics into health economic research might lead to great benefits.[2]

In the present paper, we follow the research agenda proposed by Fuchs. Our main research goal is to improve the understanding on how incentives from the payment systems FFS and CAP influence physicians' behaviour by means of a laboratory experiment. We investigate how both payments systems affect the supply of medical services at the level of the individual physician. Further, we analyse whether overprovision occurs in FFS and underprovision arises in CAP. We study whether the patient's state of health is influential for the individual physician's quantity choices, and what effects the payment system has on the patient health benefit—in particular for those with different health status.

[1] In a medical decision-making context, the early study by Fan et al. (1998) explores alternative methods for controlling the cost of physician services under global budgeting, Ahlert et al. (2008) and Hennig-Schmidt and Wiesen (2010) explore behavioural differences between medical students and other subject pools. The experimental studies by Lèvy-Garboua et al. (2008) and Schram and Sonnemans (2008) analyse issues dealing with health care funding and health insurance choice.

[2] In a similar vein, Frank (2007) suggests the application of behavioural economics that help to answer relevant issues in health economics.

To meet our research goals, we designed an experiment that captures the main features of the theoretical literature and provides results comparable to findings of field and survey studies.

In our experiment, medical students in the role of physicians choose quantities of medical services they want to provide for their patients. The number of patients and their state of health is given and constant under both FFS and CAP. The quantity a physician (she) chooses for a patient (he) determines her own profit and the patient's benefit. When deciding upon the quantity of medical services for a given patient, the physician knows about the consequential profits and the patient benefits for all quantity alternatives. The patient benefit is measured in monetary terms representing a monetary equivalent of benefits from the provision of medical services. For each patient, there exists a unique quantity indicating the best treatment for the patient as it renders the highest benefit to the patient. Optimal quantities vary across patient types. The physician's profits increase in the quantity provided under FFS and decrease under CAP. The physician faces a tradeoff between her own maximal profit and the optimal patient benefit. Patients in our experiment are abstract in that only subjects deciding as physicians take part, and no patients are present. Physicians' quantity choices have real consequences for patients outside the lab, however: the money corresponding to the benefits of the abstract patients is transferred to a charity caring for real patients. Except for the mode of payment, we kept all experimental parameters constant.

Our main finding is that physicians' supply of medical services is affected by the incentives from the payment systems. Physicians supply about 33% less medical services under CAP than under FFS. In line with theoretical considerations, patients are overprovided under FFS and underprovided under CAP. Financial incentives—and thus physicians' profits—are not the only motivation for their quantity decisions, though. The patient benefit is of considerable importance as well. However, the patient benefit is affected differently by the two payment systems; patients in need of a low level of medical services are better off under CAP, whereas patients in need of a high level of medical services gain a higher benefit when physicians are paid by FFS.

The paper is organised as follows. In Section 2, we give a brief overview of the theoretical and empirical literature on physician payment and incentives most relevant to our research topic and provide a rationale for an economic experiment. Section 3 states our research questions. In Section 4, we present the experimental design and procedure. Section 5 provides the behavioural results. Section 6 discusses our results and concludes.

2. Related literature and rationale for an experiment

The theoretical literature widely analysed how physicians respond to incentives from payment schemes (McGuire 2000). In particular, the relationship between incentives from FFS and CAP and physicians' supply of medical services has been studied (e.g., Ellis and McGuire 1986, 1990, Selden 1990). Using a principal-agent framework where the physician is the agent of the hospital and her supply of medical services is influential for her own profit and the patient's health benefit, Ellis and McGuire (1986) show that FFS embeds an incentive for overprovision whereas

CAP provides an incentive for underprovision of medical services.[3] The theoretical analysis includes the individual patient's health benefit as a major determinant of physicians' behaviour (see also Woodward and Warren-Boulton 1984, Chalkley and Malcomson 1998, Ma and Riordan 2002, Jack 2005).[4] Other authors found that besides causing underprovision of *necessary* medical services (Blomqvist 1991), CAP may lead to cream-skimming of patients with a good state of health (e.g., Newhouse 1996, Barros 2003).

Evidence from empirical analyses on the impact of payment schemes on physicians' supply of medical services is mixed. Note that these studies relate to different institutional and country-specific settings (e.g., US physician group practice, UK fundholding system) and various measures of output (e.g., weekly patient visits, number of laboratory tests).

There is empirical evidence that physicians do respond to financial incentives (see Hillman et al. 1989, Hemenway et al. 1990). Gaynor and Pauly (1990), e.g., find that payment incentives affect the 'produced' quantity of medical services in US medical group practices. Gaynor and Gertler (1995) show that physicians in group practices reduce their effort, i.e., the number of weekly office visits, when physicians' payment is changed from FFS to CAP.

Davidson et al. (1992) observe a similar behavioural pattern for US office-based primary care physicians. In their randomized controlled trial, the frequency of visits in a FFS group with high fees is higher than in a CAP group. Most studies of Health Maintenance Organizations in the USA find that managed care reduces the length of hospital stays, the number of specialist consultations and the number of hospital operations (e.g., Miller and Luft 1994). A main objection to these studies is, however, that they are unable to disentangle payment incentives and tighter administrative controls under managed care (Grytten et al. 2009).

Croxson et al. (2001) show evidence for the financial incentives of the UK fundholding system to have a strong impact on physicians' behaviour. Before enrolling, physicians intensified their hospital-based activity in order to increase their budget for the duration of the fundholding scheme. After becoming a fundholder, they decreased activities to retain the surplus of the fund.

In a before-and-after study, Krasnik et al. (1990) report that general practitioners in Denmark respond to a variation from pure lump-sum payments to CAP supplemented by a FFS component by raising diagnostic and curative services and decreasing referrals to secondary care. Concerning referral rates, Iversen and Lurås (2000) arrive at a similar result. They find referrals from primary to secondary care revealed by Norwegian general practitioners to be larger under a CAP-system with a low FFS-component than under a system with a fixed payment (practice allowance component) complemented by a FFS-payment. The increase in referrals may, however, not only be attributable to CAP, but rather to the lower FFS-component. Accounting for possible selection effects, Sørensen and Grytten (2003) show that primary care physicians in Norway under FFS have

[3] The applicability of Ellis and McGuire's model to a primary care setting is discussed by Newhouse (2002).

[4] Arrow (1963) already emphasised the importance of professional ethics and, thus, departs from a pure profit-maximizing motive when describing the behaviour of physicians.

more consultations and patient contacts as well as lower referral rates than salaried physicians.

Dumont et al. (2008) analyse data on primary care services from the Canadian province Quebec before and after a variation from FFS to a mixed system with a base wage—independent of services provided—and a reduced FFS payment. Their results suggest that physicians react to payment incentives by reducing the volume of services, but increasing the time spent per service and per non-clinical service under the mixed payment system. Disentangling selection and incentive effects, Devlina and Sarma (2008) find that FFS strongly encourages Canadian physicians to see more patients per week than in alternative payment systems like CAP.

Several studies do not support the strong link between payment incentives and physicians' supply of medical services; see Gosden et al. (2001) and Sørensen and Grytten (2003) for summaries. Hutchinson et al. (1996), for example, do not find differences when comparing hospital utilization rates in Ontario (Canada) under FFS and CAP. Hurley and Labelle (1995) do not find evidence for a clear-cut response in the provision of medical services among Canadian physicians. After controlling for characteristics of patients and general practitioners, Grytten and Sørensen (2001) find the impact of payment systems on Norwegian physicians' behaviour to be rather small.

Field studies face various methodological difficulties. Multiple and unobservable influences on physicians' decisions, context and country-specific institutions and payment system variations make the generalization and application of results to other health markets rather difficult (Gosden et al. 2001). It is not always clear whether more than one component of the payment system is varied simultaneously or whether the patient characteristics are comparable for the samples under study. Only recently, potential selection biases are accounted for (see Sørensen and Grytten 2003, Grytten et al. 2009). Finally, many field studies rely on self-reports (e.g., Gaynor and Gertler 1995, Devlina and Sarma 2008) not unlikely to differ from actual behaviour (e.g., Camerer and Hogarth 1999).

A laboratory experiment overcomes several of the deficiencies mentioned above. We are aware that this comes at some costs, such as a simplified experimental design—in reality, a physician's decision situation is much more complex, a small number of observations and low incentives.[5] Yet, a laboratory experiment is an important and valuable tool to complement field studies for a number of reasons: the researcher is able to control the decision environment in a way hardly attainable in a natural setting (see, e.g., Davis and Holt 1993, Falk and Heckman 2009). Behavioural data are gathered in experimental sessions where only the variable of interest, in our case the payment method, is varied, providing a true *ceteris paribus* change. Observed differences in physician behaviour can thus be attributed to the modification under study. Participants in experiments are randomly assigned to the experimental conditions excluding selection biases. Different from survey studies, experimental investigations are based on actual decisions associated with monetary

[5] Falk and Fehr (2003) emphasise that careful experimentation can overcome these problems. For a more general discussion on laboratory experiments in social sciences, see Falk and Heckman (2009).

rewards that are related to the participants' choices. This is a situation real physicians face in their daily practice. Finally, laboratory experiments can serve as a 'wind tunnel' before institutional changes are implemented, e.g., during a health care reform.

3. Research questions

Our first research question deals with the impact the two payment systems have on individual physicians' provision behaviour and the consequences for individual patients. According to theory and the tendency found in numerous field studies (see Section 2), we expect individual physicians to provide more services under FFS than under CAP. We are also interested in whether individual physicians' quantity choices are influenced by patients' optimal health states. As tradeoffs between achieving the patient's optimal quantity and own maximum profit occur and we anticipate physicians to put some positive weight on their profit, we expect overprovision and underprovision of medical services under FFS and CAP incentives, respectively. Finally, we analyse physicians' provision behaviour from the individual patient's point of view. We explore whether for each patient the quantity of medical services is higher under FFS than under CAP. We further investigate over- and underprovision of the individual patient for both modes of payment.

Research Question 1. *Do incentives from payment systems FFS and CAP influence the individual physician's supply of medical services? Are patients overserved under FFS and underserved under CAP?*

Our second research question is concerned with the influence of patients' states of health on the individual physician's behaviour under both payment systems. Physicians choose quantities of medical services for patients with different states of health—the so-called patient types. Patient types differ in the number of services needed to obtain the best treatment rendering the optimal patient benefit. Patients with a good state of health need low quantities, patients with an intermediate (bad) state of health need intermediate (high) quantities. Different from field studies, physicians in our experiment treat the same number of patients comprising the same types under both FFS and CAP. This allows us to investigate the quantity choices at the patient type level. If individual physicians are influenced by the patient's health status, the average medical services per patient type should correspond to the ascending order of patient optimal quantities. Finally, we are interested in over- and underprovision at the patient type level.

Research Question 2. *Does the patient's state of health influence the physicians' supply of medical services?*

The focus of our third research question is on the consequences of physicians' behaviour in terms of patients' health benefit. We investigate the benefit loss the individual patient suffers when a physician deviates from choosing the patient optimal quantity. One might think that studying average effects is sufficient for a reliable judgment on the impact of a payment system variation.

That this might be premature is shown by results from the RAND health insurance experiment (e.g., Manning et al. 1987, Newhouse and the Insurance Experiment Group 1993). Implementing different insurance systems, the authors found that all types of services fell with cost sharing. The reduced service use had nearly no adverse effect on health for the *average* person; health among the sick poor was adversely affected, though. Motivated by this finding, we expect an impact of the payment systems on benefit losses for different patient types. Due to the incentives inherent in the two systems, patients with a good state of health will probably suffer lower losses under CAP than under FFS. For those with a bad state of health, we anticipate the reverse.

Research Question 3. *Do patients with the same state of health suffer different benefit losses across payment systems?*

4. Experimental design and procedure

4.1. General design and decision situation

Each participant in our experiment is allocated to a physician's role and joins the experiment only once, either in the experimental condition FFS or in CAP. All participants are medical students supposed to become physicians in the future. We deliberately chose medical students as we expect them to identify easily with the medical decision context of our experiment.

A physician's decision task is to choose a quantity of medical services for a given patient whose health benefit is influenced by that choice. Physician i decides on the quantity of medical services $q \in \{0, 1, \ldots, 10\}$ for three patient types ($j = 1, 2, 3$) with five abstract illnesses ($k = \mathrm{A, B, C, D, E}$) each. She thus makes 15 decisions. The three types of patients account for a heterogeneous patient population. Patient types reflect the patients' different states of health—good, intermediate, and bad. The combination of patient type and illness characterizes a specific patient 1A, 1B, 1C,..., 3D, 3E. Patient types differ in the health benefit they gain from the medical services ($B_{1k}(q)$, $B_{2k}(q)$, $B_{3k}(q)$). The patient health benefit is measured in monetary terms. A physician's choice of medical services simultaneously determines the patient benefit and her own profit ($\pi_{jk}(q)$). The patient is assumed to be passive and fully insured, accepting each level of medical service provided by the physician.

Patients in our experiment are abstract, in that only subjects deciding as physicians take part and no patients are present. Physicians' quantity choices have consequences for real patients outside the lab, however, as the money corresponding to the benefits of the abstract patients is transferred to the *Christoffel Blindenmission*, a charity caring for real patients. The money supported surgical treatments of cataract patients in a hospital in Masvingo (Zimbabwe) staffed by ophthalmologists of the *Christoffel Blindenmission*.[6] This feature of our experimental design implements an incentive for the physicians to take the patient benefit into account.

To illustrate the physicians' task, Figure 1 provides the decision screen for patient 1E under

[6]Notice that we did not inform the participants about the money being assigned to a developing country.

Figure 1: Decision screen for patient 1E in FFS

Patient type 1 / Illness E

Medical services	Quantity	Your Payment (in Taler)	Your Cost (in Taler)	Your Profit (in Taler)	Patient benefit (in Taler)
none	0	0.00	0.00	0.00	0.00
Service E1	1	1.00	0.10	0.90	0.75
Service E1, Service E2	2	2.00	0.40	1.60	1.50
Service E1, Service E2, Service E3	3	6.00	0.90	5.10	2.00
Service E1, Service E2, Service E3, Service E4	4	6.70	1.60	5.10	7.00
Service E1, Service E2, Service E3, Service E4, Service E5	5	7.60	2.50	5.10	10.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6	6	11.00	3.60	7.40	9.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7	7	12.30	4.90	7.40	9.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8	8	18.00	6.40	11.60	8.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9	9	20.50	8.10	12.40	8.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9, Service E10	10	23.00	10.00	13.00	7.50

Your Decision:

Please indicate the quantity of medical services you wish to provide.

OK

FFS. The physician gets information on her payment, costs and profit, as well as on the patient's benefit for each quantity from 0 to 10. All monetary amounts are in Taler, our experimental currency, the exchange rate being 1 Taler = EUR 0.05. The first two columns of the screen comprise the medical services and the corresponding quantities. The third column indicates the physician's payment that increases in the quantity of medical services. Recall that in CAP the payment remains the same for all quantities, as subjects receive a lump sum per patient (see instructions in the Appendix). Column 4 shows the costs of medical services that are assumed to be constant across patient types and conditions. Physician's profit (payment minus costs) is given in the fifth column, and the final column comprises the patient benefit.

4.2. Parameters

In FFS, physicians receive a fee for each unit of medical services provided; thus, the payment increases in q. The payment differs with illnesses, i.e., $R_{jA}(q), R_{jB}(q), \ldots, R_{jE}(q)$. As a guideline for specifying the payment, we used the German scale of charges and fees for physician services (*Einheitlicher Bewertungsmaßstab*, EBM), in particular the tariffs for ophthalmologist services like the treatment of glaucoma or cataract. Under CAP, physicians are paid a lump sum of 12 Taler per patient, an amount close to the average maximum profit per patient a subject could achieve under FFS. See panel I in Table A.1 for an overview of all payment parameters.

Patient benefit $B_{jk}(q)$ is shown in panel IV of Table A.1. Although the patient benefit varies across patient types, a common characteristic of $B_{jk}(q)$ is a global optimum on the quantity interval $[0, 10]$. There is a unique quantity q^*_{jk} yielding the highest benefit to patients of type j for illnesses k. We use a concave patient benefit function like many theoretical papers (e.g., Ellis and McGuire

1986, Ma 1994, Choné and Ma 2010). The patient optimal quantities are $q^*_{1k} = 5$, $q^*_{2k} = 3$ and $q^*_{3k} = 7$ for patient types 1, 2, 3, respectively—and, again, are known to the physicians. Taking q^*_{jk} as the benchmark for the best medical treatment, we are able to identify overprovision and underprovision.[7]

Further parameters relevant for physicians' decisions are costs $c_{jk}(q)$ and, particularly, profit $\pi_{jk}(q)$ shown in panels II and III of Table A.1. Physicians have to bear costs $c_{jk}(q) = \frac{1}{10} \cdot q^2$ in both conditions.[8] Profits vary across illnesses in FFS because payment differs, and costs are kept constant. In CAP, profit is constant across illnesses. In FFS, the profit-maximizing quantity $\hat{q}_{jk}$ is 10 for all patients, except for those with illness A, i.e., patients 1A, 2A and 3A, as $\hat{q}_{jA} = 5$. For patient 1A, $\hat{q}_{1A} = q^*_{1A} = 5$. Under CAP, a profit-maximizing subject would not provide any medical service, i.e., $\hat{q}_{jk} = 0$ for all patients.

4.3. Experimental protocol

Our computerized experiment—programmed with z-Tree (Fischbacher 2007)—was conducted at *B*onn*E*con*L*ab, the Laboratory for Experimental Economics at the University of Bonn. 42 medical students were recruited via the online recruiting system ORSEE (Greiner 2004); 20 of them participated in FFS and 22 in CAP.[9]

The experimental procedure in both conditions was as follows: upon arrival, subjects were randomly allocated to the cubicles where they took their decisions in full anonymity. Then, the experimenter read the instructions aloud. Subjects were given plenty of time for clarifying questions which were asked and answered in private. To check for subjects' understanding of the decision task, they had to answer three test questions. Each participant then made 15 choices on the quantity of medical services. The order of patients to be treated was predetermined and kept constant across conditions. After the experiment, subjects were paid in private according to their choices.

To validate the actual transfer of the money, we applied a procedure like Eckel and Grossman (1996). After all subjects had been paid, a monitor randomly selected from the participants verified that a check on the benefits of all patients was written. The check was sealed in an envelope addressed to the *Christoffel Blindenmission*. The monitor and experimenter then walked together to the nearest mailbox and deposited the envelope. The monitor was paid an additional 4.00 EUR (see also the instructions in the Appendix).

Sessions lasted for 30 to 40 minutes. Subjects on average earned 6.88 EUR in FFS and 7.42 EUR

[7] From a medical point of view, there might be many acceptable treatment variations. This is not addressed in our simplified experimental setup. Rather, we assume that a specific amount of medical services provides the patient with the optimal health benefit.

[8] Convex cost functions are assumed in several theoretical models of physician behaviour (e.g., Ma 1994 and Choné and Ma 2010).

[9] Medical students who registered in ORSEE for laboratory experiments at *B*onn*E*con*L*ab were invited via automatically generated e-mails to participate in two experimental sessions of our experiment. When signing up, subjects neither knew anything about the decision task nor about the fact that only medical students were asked to participate. This procedure guaranteed the random allocation of students to the two experimental conditions and excluded self-selection into payment schemes.

in CAP.[10] In total, 273.68 EUR were transferred to the *Christoffel Blindenmission*, 6.62 EUR per participant in FFS and 6.42 EUR in CAP. As the average cost for a surgical treatment of cataract patients amounts to about 30 EUR, the money from our experiment allowed to treat nine real patients.

5. Results

5.1. Physicians' provision behaviour

Research Question 1 is concerned with the influence of FFS and CAP on the individual physician's choice of medical services and the consequences for individual patients. Before turning to this analysis, we compare behaviour in FFS and CAP at the aggregate level. The descriptive statistics in Table 1 show a marked difference. Overall, physicians provide 33% less medical services under CAP than under FFS. This corresponds to tendencies reported in field studies (e.g., Gaynor and Pauly 1990, Gaynor and Gertler 1995; see also Sørensen and Grytten 2003).

Table 1: Physicians' quantity choices under FFS and CAP

Payment	Mean	Median	s.d.	obs.	p
FFS	6.60	7.00	1.85	300	0.0021
CAP	4.40	5.00	1.64	330	0.0105

p-values relate to a two-sided Wilcoxon signed rank test comparing $\overline{q}_{jk}$ with q^*_{jk}.

The behavioural difference between payment systems persists when comparing individual physicians' quantity choices averaged over all 15 decisions. Physicians under FFS provide highly significantly more medical services than under CAP.[11] This already indicates that physicians are influenced by payment incentives—and, thus, by their own profit.[12]

We next investigate over- and underprovision, i.e., providing more or less than the optimal quantity for the patient. If the individual physician were only motivated by the optimal quantity for the patient and the payment system had no impact on her choices, she would always choose q^*_{jk} under both payment systems. She would end up providing an average (and a median) quantity of 5 medical services. Over- and underprovision would be no issue. Our experimental data disconfirms this conjecture. We found only two physicians in FFS and four physicians in CAP who behave accordingly (see Table A.2). Thus, in both conditions the number of physicians who deviate in their choices from the optimal quantity for the patient is significantly higher than the number of

[10] Average payoffs correspond to the hourly wage of a student helper at the University of Bonn (8.32 EUR). A lunch at the student cafeteria is around 2.50 EUR.

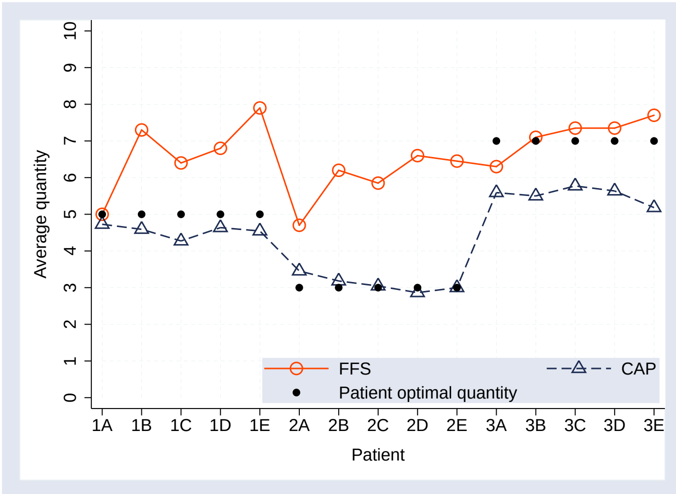
[11] $p = 0.0000$, Mann Whitney U-test. All test statistics are two-sided.

[12] This result is further corroborated when comparing provision behaviour from a patient's point of view. Here, $\overline{q}^{FFS}_{jk} > \overline{q}^{CAP}_{jk}$ for all patients jk. This is highly significant ($p = 0.0000$, Mann-Whitney U test). This result even persists at an *individual* decision level. Except for patients 1A and 3A, $q^{FFS}_{ij} > q^{CAP}_{ij}$ ($p \leq 0.0010$, Mann-Whitney U test). In FFS, a significantly higher number of patients is provided with significantly more medical services compared to CAP ($p = 0.0070$, binomial test).

those who do not.[13]

At last, we analyse the impact the average physician's supply of medical services has for the

Figure 2: Average quantity of medical services per patient



individual patient. For both conditions, Figure 2 shows the average quantities of medical services $\overline{q}_{jk}$ chosen for each patient jk and the patient optimal quantities q^*_{jk} allowing to identify over- and underprovision. In FFS, 13 patients are overserved on average; this is the case for patients where the profit-maximizing quantity $\hat{q}_{jk}$ is larger than q^*_{jk}.[14] We observe a different pattern under CAP. Here, $\overline{q}_{jk} < q^*_{jk}$ for 11 patients. Testing over all 15 patients, we find that physicians provide medical services significantly larger than optimal for patients in FFS and significantly lower than optimal in CAP; for test statistics see Table 1.

Result 1. *The individual physician's supply of medical services is influenced by the two payment systems. Physicians provide more services under FFS than under CAP. Patients are overserved in the former and underserved in the latter.*

5.2. Patients' state of health

Our second research question investigates whether patient types influence the individual physician's supply of medical services. The three patient types in our experiment are characterized by different health states; patients of type 1 (2, 3) need 5 (3, 7) medical services to obtain their optimal benefit (Table A.1 and Figure 2). If physicians are influenced by the patient types, but not by the payment system, they should choose average quantities near or equal to q^*_{jk} in FFS *and* in CAP. Descriptive statistics in Table 2 indicate that this is not the case.

Common across payment systems, however, is the order of average quantities for the three types of patients, $\overline{q}_{2k} < \overline{q}_{1k} < \overline{q}_{3k}$. We now test whether this order is the result of choices systematically

[13] FFS: $p = 0.0004$; CAP: $p = 0.0022$, binomial test.
[14] Patient 1A is treated optimally by all physicians, whereas patient 3A is even underserved.

Table 2: Physicians' quantity choices under FFS and CAP by patient type

Payment	Variable	Mean	Median	s.d.	obs.	p
FFS	q_{1k}	6.68	6.00	1.80	100	0.0001
	q_{2k}	5.96	6.00	2.32	100	0.0001
	q_{3k}	7.16	7.00	0.95	100	0.1846
CAP	q_{1k}	4.55	5.00	1.33	110	0.0219
	q_{2k}	3.11	3.00	0.89	110	0.3042
	q_{3k}	5.54	6.00	1.61	110	0.0001

p-values relate to a two-sided Wilcoxon signed rank test comparing physicians' average quantity choices for each patient type j with q^*_{jk}.

influenced by the different patient types. To this end, we apply an order test (Selten 1967) that for each physician compares the observed order of average medical services per patient type with the perfect ascending order of optimal quantities.[15] There are six possibilities to assign the three ranks. The null hypothesis is that for each subject the order of observed values is arbitrary. For both payment schemes, the null hypothesis can be rejected at the 1% level.

Next, we check for over- and underprovision when patient types are accounted for. We find adverse effects in both payment systems. Under FFS, patients with an intermediate and a good health state, i.e., patients of type 1 and 2, are significantly *over*served (for test statistics, see Table 2). The average quantity of medical services for patients of type 3 does not statistically differ from the optimal quantity for the patient, though. Under CAP, patients of types 1 and 3 are significantly *under*served, whereas average quantities supplied for patient type 2 are not statistically different from being optimal.

Result 2. *Patients' health status systematically influences physicians' supply of medical services in both payment systems, yet in different directions. While physicians in FFS overserve patients in a good and intermediate state of health, physicians in CAP underserve patients in a bad and intermediate state of health.*

5.3. Patient health benefit

Our third research question focusses on how the patient benefit is affected by the payment systems via the individual physician's provision behaviour. Our design specifies the patient benefit for each choice of medical services. We, therefore, can compute the patient benefit loss which is the amount the individual patient forgoes in his benefit whenever a physician i deviates from choosing q^*_{jk}. To facilitate the comparison across patient types, we consider the proportional benefit loss

[15] The logic behind the order test is the following. When a physician's quantity choice is influenced by patient types q^*_{jk}, patients in need of a large (intermediate, low) quantity of medical services should on average receive a large (intermediate, low) amount of medical treatment. If a physician behaves accordingly, the ranks assigned to the mean quantities provided per patient type should follow a 'perfect' order, i.e., 2, 1, 3, as $q^*_{2k} < q^*_{1k} < q^*_{3k}$. A measure for the difference between the actual order and the perfect order is the number of inversions, i.e., the number of pairwise changes necessary to transform the given order into the perfect order. We calculate the average quantity per patient type for each of those 16 physicians whose observed order comprises three different values and rank them according to their magnitude. For each physician, we then calculate the number of inversions necessary to achieve the perfect order of ranks.

$L_{jk} = \left[\frac{B(q^*_{jk})-B(q^i_{jk})}{B(q^*_{jk})}\right]$, the benefit loss relative to the patient benefit at the optimal treatment.

In FFS, the proportional benefit loss averaged over all patients $\overline{L}_{jk}$ is almost 10 percent (mean 0.0995, s.d. 0.0860); under CAP, it is slightly larger (mean 0.1291, s.d. 0.2032). These numbers seem to suggest that the patient benefit loss is not much affected by the payment systems. Yet, the picture is different when focusing on patient types.

Patients with a good health status (patient type 2) experience a significantly smaller loss in health benefit under CAP compared to FFS. On the contrary, for patients with an intermediate or a bad state of health the proportional patient benefit loss is smaller, although not significantly, under FFS than under CAP. (see Table 3)

Table 3: Proportional benefit loss by patient type

Payment	L_j	Patient type 1	Patient type 2	Patient type 3
FFS	Mean	0.09	0.15	0.06
	Median	0.05	0.15	0.05
	s.d.	0.11	0.12	0.10
CAP	Mean	0.15	0.07	0.17
	Median	0.00	0.00	0.05
	s.d.	0.28	0.22	0.23
	p	0.5445	0.0009	0.1847

p-values relate to a two-sided Mann-Whitney U-test comparing $\overline{L}_j$ across payment systems.

Result 3. *Payment systems have an adverse effect on patient benefit losses for different patient types. Patients with a good health status suffer from a larger benefit loss under FFS than under CAP. For patients with an intermediate and a bad state of health we find the opposite tendency.*

6. Discussion and concluding remarks

In this paper, we examine the impact of the two payment methods fee-for-service and capitation on the behaviour of individual physicians. To this end, we introduced a fully incentivized laboratory experiment and implemented a controlled *ceteris paribus* change of the payment scheme.

We find a marked influence of the payment system on the individual physician's behaviour. Similar to results from field studies, physicians in our experiment provide significantly more medical services under FFS than under CAP. In line with the theoretical literature, patients in our experiment are overserved under FFS and underserved under CAP.

Another main insight is that patients' health status systematically influences the physician's supply of medical services in both payment systems. Yet, the impact points in different directions. While physicians in FFS overserve patients in a good and intermediate state of health, physicians in CAP underserve patients in a bad and intermediate state of health.

Finally, the individual physician's decisions are motivated not only by her own profit; the patients' health benefit is of considerable importance as well. In both payment schemes, we find rather small average losses in patient benefits due to physicians deviating from the optimal treatment. Even though this result suggests nearly no impact of the payment system on the patient benefit loss, the picture looks different when concentrating on patient types. Patients with a good state of health suffer a larger benefit loss under FFS than CAP, whereas for patients with an intermediate and a bad health state we find the opposite tendency.

Our experimental approach and our findings might be and have been subject to critical concerns. In the following, we deal with the most important ones like contribution of our study to the health economics literature, selection bias, and generalizability of our results.[16]

The results from our laboratory experiment are consistent with related findings from empirical health economics studies that use more traditional designs like surveys or controlled trials (see our literature review in Section 2). One, therefore, might wonder about the contribution of our study to the literature. For one thing, we think it is noteworthy that our simplified experimental setting is able to generate results in line with findings from outside the lab. Not only for that reason, the experimental method seems a valuable research tool and an ideal complement to other empirical methods.

Moreover, our laboratory experiment provides additional features that are difficult to find in the field. To start with, we are able to test theoretical predictions on overprovision in FFS and underprovision in CAP (e.g., Ellis and McGuire 1986) in that the optimal patient benefit could be specified in the experiment. In fact, our results are in line with these predictions. Testing for over- and underprovision is hardly possible outside the lab as the required data are usually not available. Second, we compare behaviour under true *ceteris paribus* conditions as only the payment system is changed; patient characteristics and the number of patients stay constant, a situation hardly warranted in the field. Third, the lab experiment enables thorough robustness checks of the findings because it can be repeated by different scientists under exactly the same conditions. Running the same design in different countries facilitates cross-country comparability as it allows to dispense with country-specific institutions. Fourth, by random assignment of participants to experimental conditions, the self-selection bias of physicians into payment systems is avoided from the outset. Grytten et al. (2009), for instance, argue that a random allocation of physicians to payment schemes, although an ideal design, is difficult to do in practice. Finally, a laboratory experiment requires much less time and financial means than many other empirical methods. It might have great potential as 'test bed' before large-scale studies or institutional changes of the health care market are planned.

One might argue that the medical students who participate in our experiment are the ones most interested in earning money. This might lead to an overestimation of the payment effect as these students strive for higher profits than non-participating medical students less driven by financial incentives. We cannot completely rule out such a bias as we have no information on the characteristics and likely behaviour of non-participants. Some studies, however, suggest the potential bias to be negligible. Falk et al. (2010) compare pro-social behaviour of a large student

[16] We thank an anonymous referee for raising these issues.

subject pool with a subset of students who take part in experiments. The authors do not find evidence for statistical differences between participants and non-participants; see also Cubitt et al. (forthcoming) for related findings. Our own data also suggest that it is not the most profit-oriented medical students who participate in our experiment. Patients, on average, only suffer mild losses of their health benefit due to non-optimal quantity choices. The mean fraction of profit-maximizing choices is only 8%, and no physician always goes for her maximal profit. If only the most profit-oriented medical students had participated in our experiment we would have observed much more egoistic behaviour. A comparison of medical and non-medical students actually showed that the former were significantly less profit-oriented than the latter (Hennig-Schmidt and Wiesen 2010).

Another point of concern might relate to the generalizability of our findings to the clinical setting where real physicians have to focus on the medical condition and characteristics of real patients; medical students have neither the knowledge nor the experience of qualified physicians. The main goal of our study is to isolate the *causal relationship* between change in the payment system and the individual physician's behaviour; see also the general discussion by Falk and Heckman (2009). To this end, all factors potentially influencing behaviour other than the payment system are held constant. Guided by the theoretical models, we simplified the experimental design and specified patient types, optimal treatment and abstract illnesses. Abstracting from a clinical environment in this way, to us, is an advantage rather than a deficiency as the participating medical students need not worry about the specific medical services or how to combine them for treating a patient optimally. We are aware that the present experiment only allows us to draw qualitative conclusions and not to assess actual behaviour in a real clinical setting. We have to leave the analysis of other factors relevant for physicians' behaviour to future research.

A further simplification is how we incorporate the patient in our experiment—we express the patient benefit in monetary terms. By this device, we included a real incentive to care for a patient as the physician's decision is consequential for the medical treatment of real patients outside the lab. The patients and their benefit actually were a major determinant of subjects' decisions as mentioned by almost all participants when answering open questions after the experiment.

What can we say about policy implications of our findings having in mind the qualitative nature of our conclusions? In a situation as specified by our experimental design, a third-party payer would have to bear 16% more costs to remunerate a physician in FFS than in CAP. From a pure expenditure point of view, CAP would be, thus, the preferable payment system to be implemented. Yet, we also found that patients are affected differently by both payment systems: patients in need of a low level of medical services are better off under CAP, whereas patients with a high need of medical services are better off under FFS. These findings reveal a tension on how remuneration costs and benefit gains and losses are to be weighed against each other. We as scientists do not feel competent to make recommendations which payment scheme should actually be implemented. This is rather a matter of political decision-makers' preferences and priorities.

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Appendix A. Tables

Table A.1: Experimental parameters

	Condition	Variable	Quantity (q)										
			0	1	2	3	4	5	6	7	8	9	10
I	FFS	$R_{jA}(q)$	0.00	1.70	3.40	5.10	5.80	10.50	11.00	12.10	13.50	14.90	16.60
		$R_{jB}(q)$	0.00	1.00	2.40	3.50	8.00	8.40	9.40	16.00	18.00	20.00	22.50
		$R_{jC}(q)$	0.00	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20	18.30
		$R_{jD}(q)$	0.00	2.00	4.00	6.00	8.00	8.20	15.00	16.90	18.90	21.30	23.60
		$R_{jE}(q)$	0.00	1.00	2.00	6.00	6.70	7.60	11.00	12.30	18.00	20.50	23.00
	CAP	$R_{jk}(q)$	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
II	FFS, CAP	$c_{jk}(q)$	0.00	0.10	0.40	0.90	1.60	2.50	3.60	4.90	6.40	8.10	10.00
III	FFS	$\pi_{jA}(q)$	0.00	1.60	3.00	4.20	4.20	8.00	7.40	7.20	7.10	6.80	6.60
		$\pi_{jB}(q)$	0.00	0.90	2.00	2.60	6.40	5.90	5.80	11.10	11.60	11.90	12.50
		$\pi_{jC}(q)$	0.00	1.70	3.20	4.50	5.60	6.50	7.20	7.70	8.00	8.10	8.30
		$\pi_{jD}(q)$	0.00	1.90	3.60	5.10	6.40	5.50	11.40	12.00	12.50	13.20	13.60
		$\pi_{jE}(q)$	0.00	0.90	1.60	5.10	5.10	5.10	7.40	7.40	11.60	12.40	13.00
	CAP	$\pi_{jk}(q)$	12.00	11.90	11.60	11.10	10.40	9.50	8.40	7.10	5.60	3.90	2.00
IV	FFS, CAP	$B_{1k}(q)$	0.00	0.75	1.50	2.00	7.00	10.00	9.50	9.00	8.50	8.00	7.50
		$B_{2k}(q)$	0.00	1.00	1.50	10.00	9.50	9.00	8.50	8.00	7.50	7.00	6.50
		$B_{3k}(q)$	0.00	0.75	2.20	4.05	6.00	7.75	9.00	9.45	8.80	6.75	3.00

This table shows all experimental parameters. $R_{jk}(q)$ denotes physicians' payment for patient type j and illness k. Under FFS, $R_{jk}(q)$ varies with illnesses k and increases in q, whereas under CAP, $R_{jk}(q)$ remains constant. The costs for providing medical services $c_{jk}(q)$ increase in q and are the same under FFS and CAP. Physicians' profit $\pi_{jk}(q)$ is equal to $R_{jk}(q) - c_{jk}(q)$. $B_{jk}(q)$ denotes the patient benefit for the three patient types $j = 1, 2, 3$ held constant across payment systems. Notice that due to a display error on the computerized decision screens, $R_{jA}(4) = 8.40$ instead of 5.80 was shown in FFS. Physicians' profits were displayed correctly, however.

Table A.2: Individual physicians' choices of medical services under FFS and CAP

	FFS			CAP		
Physician	Mean	Median	s.d.	Mean	Median	s.d.
1	6.40	7.00	1.12	4.20	5.00	1.52
2	7.73	8.00	1.87	4.27	5.00	0.88
3	5.00	5.00	1.46	4.80	5.00	1.47
4	5.00	5.00	1.69*	5.13	5.00	1.60
5	7.27	8.00	1.16	2.13	2.00	0.83
6	6.40	6.00	1.12	5.00	5.00	1.69*
7	7.13	7.00	1.06	4.07	4.00	0.96
8	8.27	9.00	1.94	4.33	5.00	0.98
9	6.07	7.00	1.39	4.07	4.00	0.80
10	7.67	7.00	1.76	5.00	5.00	1.69*
11	7.47	8.00	2.00	4.93	5.00	1.62
12	6.93	7.00	1.75	4.93	5.00	1.62
13	6.13	6.00	1.92	2.40	2.00	1.18
14	6.27	7.00	1.33	5.00	5.00	1.69*
15	8.53	9.00	1.96	4.00	4.00	0.85
16	6.67	6.00	1.54	4.47	5.00	1.85
17	5.00	5.00	1.69*	3.40	4.00	1.68
18	5.73	6.00	1.49	4.53	5.00	1.19
19	7.00	7.00	1.25	6.00	6.00	2.45
20	5.33	5.00	1.45	4.67	5.00	1.29
21	.	.	.	5.00	5.00	1.69*
22	.	.	.	4.47	5.00	1.13
Overall	6.60	7.00	1.85	4.40	5.00	1.64

* indicates physicians who always choose the patient optimal quantity.

Appendix B. Instructions

[*translated from German*]

General Information

In the following experiment, you will make several decisions. Following the instructions and depending on your decisions, you can earn money. It is therefore very important to read the instructions carefully.

You take your decisions anonymously in your cubicle on your computer screen. During the experiment you are not allowed to talk to any other participant. Whenever you have a question, please raise your hand. The experimenter will answer your question in private in your cubicle. If you disregard these rules you can be excluded from the experiment without receiving any payment.

All amounts of money in the experiment are stated in Taler. At the end of the experiment, your earnings will be converted into Euro at an exchange rate of 1 Taler = 0.05 EUR and paid to you in cash.

Your decisions in the experiment

During the entire experiment you are in the role of a physician. You have to decide on the treatment of 15 patients. All participants of this experiment are taking their decisions in the role of a physician. You decide on the **quantity** of medical services you want to provide for a given illness of a patient.

You decide on your computer screen where five different illnesses—A, B, C, D and E—of three different patient types—1, 2 and 3—will be shown one after another. For each patient, you can provide $0, 1, 2, 3, 4, 5, 6, 7, 8, 9$ or 10 medical services.

Your payment is as follows:

- *Condition FFS*:

  A different PAYMENT is assigned to each **quantity** of medical services. The PAYMENT increases in the **quantity** of medical services.

- *Condition CAP*:

  For each patient you receive a lump-sum PAYMENT that is independent of the **quantity** of medical services.

While deciding on the **quantity** of medical services, in addition to your PAYMENT you determine the COSTS you incur when providing these services. COSTS increase with increasing **quantity** provided. Your PROFIT in Taler is calculated by subtracting your COSTS from your PAYMENT.

A certain benefit for the patient is assigned to each quantity of medical services, the PATIENT BENEFIT that the patient gains from your provision of services (treatment). Therefore, your decision on the **quantity** of medical services not only determines your own PROFIT, but also the PATIENT

BENEFIT. An example for a decision situation is given on the following screen.

Screen shot FFS

Patient type 1 / Illness E

Medical services	Quantity	Your Payment (in Taler)	Your Cost (in Taler)	Your Profit (in Taler)	Patient benefit (in Taler)
none	0	0.00	0.00	0.00	0.00
Service E1	1	1.00	0.10	0.90	0.75
Service E1, Service E2	2	2.00	0.40	1.60	1.50
Service E1, Service E2, Service E3	3	6.00	0.90	5.10	2.00
Service E1, Service E2, Service E3, Service E4	4	6.70	1.60	5.10	7.00
Service E1, Service E2, Service E3, Service E4, Service E5	5	7.60	2.50	5.10	10.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6	6	11.00	3.60	7.40	9.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7	7	12.30	4.90	7.40	9.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8	8	18.00	6.40	11.60	8.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9	9	20.50	8.10	12.40	8.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9, Service E10	10	23.00	10.00	13.00	7.50

Your Decision:

Please indicate the quantity of medical services you wish to provide.

OK

Screen shot CAP

Patient type 1 / Illness E

Medical services	Quantity	Your Payment (in Taler)	Your Cost (in Taler)	Your Profit (in Taler)	Patient benefit (in Taler)
none	0	12.00	0.00	12.00	0.00
Service E1	1	12.00	0.10	11.90	0.75
Service E1, Service E2	2	12.00	0.40	11.60	1.50
Service E1, Service E2, Service E3	3	12.00	0.90	11.10	2.00
Service E1, Service E2, Service E3, Service E4	4	12.00	1.60	10.40	7.00
Service E1, Service E2, Service E3, Service E4, Service E5	5	12.00	2.50	9.50	10.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6	6	12.00	3.60	8.40	9.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7	7	12.00	4.90	7.10	9.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8	8	12.00	6.40	5.60	8.50
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9	9	12.00	8.10	3.90	8.00
Service E1, Service E2, Service E3, Service E4, Service E5 Service E6, Service E7, Service E8, Service E9, Service E10	10	12.00	10.00	2.00	7.50

Your Decision:

Please indicate the quantity of medical services you wish to provide.

OK

You decide on the **quantity** of medical services on your computer screen by typing an integer between 0 and 10 into the box named "Your Decision".

There are no real patients participating in this experiment, but abstract ones. Yet, the PATIENT BENEFIT an abstract patient receives by your providing medical services will be beneficial for a real patient. The total amount corresponding to the sum over all 15 PATIENT BENEFITS determined by your decisions will be transferred to the charity *Christoffel Blindenmission Deutschland e.V., 64625 Bensheim*, to support an ophthalmic hospital where patients with cataract are treated.

Earnings in the experiment

After having made your 15 decisions, your overall earnings will be calculated by summing up the PROFITS from all your decisions. This amount will be converted from Taler into Euro at the end of the experiment.

The overall PATIENT BENEFIT resulting from your 15 quantity decisions will be converted into Euro as well and will be transferred to the *Christoffel Blindenmission*. The transferral will be made by the experimenter and a monitor. The monitor writes a check on the amount of money corresponding to the aggregated PATIENT BENEFITS of this experiment. This check issued to the *Christoffel Blindenmission* will be sealed in an envelope addressed to this charity. The monitor and experimenter then walk together to the nearest mailbox and deposit the envelope.

After all participants have taken their decisions, one participant is randomly assigned the role of the monitor. The monitor receives a payment of 4 EUR in addition to the payment from the experiment. The monitor verifies, by a signed statement, that the procedure described above was actually carried out. Next, please answer some questions familiarizing you with the decision situation. After your 15 decisions, please answer some further questions on your screen.