How specificity and presentation of data affect our rational decision-making ability, oriented to a pharmaceutical perspective.

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Vorgelegt von Felix Wolfrum, geb. am 22.12.1986 in Berlin

Aus Leverkusen

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Begutachtet von:

Prof. Dr. Philipp Wichardt; Institut für Volkswirtschaftslehre; Universität Rostock

Prof. Dr. Yvonne-Beatrice Böhler; Fakultät für angewandte Naturwissenschaften; TH Köln

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Introduction

Health is a scarce commodity. It is something that costs us a lot around the world. In 2019, spending on health care alone amounted to 8.8 % of gross domestic product worldwide (OECD, 2019). In Germany, this amounts to around € 250 billion in 2020, of which € 43 billion will be spent on pharmaceuticals alone (GKV, 2020). This does not yet include the increased costs of the last two years due to the SARS-COV-2 pandemic. In general, these expenditures are always subject to complex strategic multiparty interactions, especially in the area of pharmaceuticals (Vogler et al., 2018). However, these are always susceptible to subjective perception and misinterpretation (e.g., Camerer, 2003; Hoffrage et al., 2002; Marewski et al., 2012; Gigerenzer et al., 2011a).

This dissertation aims to show the influence of factors on our perception and consequent evaluation of data, respectively our assessment of situations. Furthermore, it deals with the question to what extent rationally abstracted processes are common and applied in negotiation situations in the medical-pharmaceutical field. This is done through three articles in this dissertation.

The first article deals with the question how far game theoretical models - as an example for abstracted rational decision making (Roth, 1991; Romp, 1997; Samuelson, 2016) - are used within the health care sector. As a proxy, the databases PubMed and LIVIVO were used, as they are specialized in medical communities, see Müller et al. (2017) and Shariff et al. (2013). For this purpose, a systematic search - following the methodology of the Cochrane Review - with Boolean operators was conducted, which should reveal possible application scenarios of game-theoretical models, especially in relation to price negotiations.

As a result, a total of 126 articles were found in which game theoretic models were applied, whereas only three of them dealt with price negotiation situations. These three articles showed in retrospective a possible practical use of game theory as a rational tool, see Harris et al. (2016), Ramani and Urias (2015) and Wright (2004). This shows that only a small part of these constellations is used. In the following, the articles on game theory were categorized - *Administration; Caregiver; Disease Management; E-health; Hospital; Patients; Healthcare Professionals; Resource Allocation; Vaccination* - and edited. Overall, it appears that game theory

approaches are used very heterogeneously in the medical-pharmaceutical field but are still not fundamentally considered as a familiar tool.

Based on this, the second article considered how individuals evaluate pharmaceuticals and whether this is done rationally. For this purpose, the core profile of two different fictitious medicines - based on GBA (joint federal committee) analyses (see GBA, 2019a, 2019b) - comprising positive and negative effects was presented in different representations in a survey with 1200 subjects. The presentations were varied once in table or text, as well as percent and natural frequency. So that with the two drugs used, eight different combinations were obtained.

The result shows that a tabular presentation leads to fundamentally higher evaluations than textual presentations. The presentation as percentages versus natural frequencies also shows a difference, but this is not always significant. This shows that in a scenario where a drug is not clearly better in all areas, the risks cannot be ideally assessed. This is consistent with the findings of Gigerenzer et al. (2007), Gaissmaier and Gigerenzer (2008), Operskalski and Barbey (2016) and Wegwarth and Gigerenzer (2017), which show that natural frequencies can be better interpreted in terms of probability. Overall, this shows that our evaluation of drugs and their risks is presumably less rational than it should be.

Building on this, the third article addresses the question of how we as individuals perceive and evaluate risks. For this purpose, the SOEP (Socio-Economic-Panel) data set was used and the answers of the subjects to the risk questions were analysed. Here, the stated preferences method of risk assessment is used, see Dohmen et al. (2011).

The panel analysis conducted here shows that the more specific the risk question is, the more often the 0 risk category is selected. This indicates that the general risk question cannot be represented by a weighted average of the domain-specific questions.

Complementary to this, it is shown that fear leads to an increased tendency to indicate 0. This is consistent with research findings from fear research. Wake et al. (2012) demonstrate in a meta study that fear has a significant impact on our risk-taking behaviour.

Overall, this dissertation indicates that limited evidence of abstracted approaches in the medical-pharmaceutical context can be found in practical application in operational situations. This is remarkable, because it is shown more clearly that drug evaluations, in particular the risks, are subject to strong subjective factors that distort the results. On the one hand, by the presentation of the data and on the other hand by the personal assessment of the risk, here represented by the stated preferences questions. This becomes especially clear in the third study, which shows that the risk assessment of individuals depends on the specificity of the question, as well as the personal perception of fear.

Chapter 1: A PubMed overview about the implementation of game theory in healthcare and pharmaceutical negotiations

Felix Wolfrum

Faculty of Applied Natural Sciences, TH Köln;

Dept. of Economics, University of Rostock

1.1 Abstract

Objectives

Game-theoretic models are a standard tool in economics to model strategic interaction of various types, e.g., negotiations. This research aims to investigate to what extent these models occur in the health literature and are applied and used in real scenarios, especially with negotiations and pharmaceutical pricing from a healthcare professional perspective by using PubMed.

Methods

PubMed (Medline) and LIVIVO were searched by search operators modelled after PICOS schemes. Eligibility criteria included price negotiations vs. general healthcare negotiations (focusing drug context) using game theory. The extraction included English-language articles published from 1 January 2004 to 31 March 2019.

Results

A total of 1168 documents were retrieved. 796 full texts (excluding 372 duplicates) were screened. Of these, 126 included the application of game theory, research on negotiations were carried out in 109 cases, the intersection covers five cases. In these five cases, a model was presented explaining the process dependencies of the negotiations. In the cases with price negotiations, (3) substantial parts of the structure could be explained. Apart from negotiations, game theory in the health care literature is mainly applied in the following three areas: *Vaccination* cases (13), scenarios with *Resource Allocation* (20), and approaches to *Administrative Problems* (10). In addition, empirical studies based on statistically evaluable data were obtained in 282 cases.

Conclusions

In relation to the relevance of various negotiations in healthcare, game theory approaches are rarely used to obtain a better understanding of the

underlying incentive structures. Given that reliable data on health care issues, especially pharmaceutical pricing, are notoriously difficult to get, the question arises whether the few process-focused studies are due to particularities of the science or whether there is simply a gap in potentially valuable research to be filled.

1.2 Introduction

At 8.8 %, health expenditure accounts for a significant share of the gross domestic product (OECD, 2019). Looking at the expenditure of Germany's statutory health insurance funds, this is around € 250 billion in absolute terms, of which € 43 billion is accounted for by pharmaceuticals alone (GKV, 2020). These expenditures are always subject to complex multiparty strategic interactions, e.g., negotiations. Especially in the case of pharmaceuticals with their country-specific and complex reimbursement mechanisms and the negotiations involved (Vogler et al., 2018).

In theory, negotiations are described as the interaction between several parties to find a common agreement (Thompson, 2006). According to Thompson (2006), this research is very diverse and diffuses partly into exclusive specialist research areas.

For example, one area focuses on bounded rationality and bias effects in his negotiation theories, which influence the outcome (Bazerman and Neale, 1986; Chugh and Bazerman, 2007). In addition to this, the influence of the negotiator on the negotiations is examined and presented, as well as their self-assessment and decision-making (De Dreu and Carnevale, 2003; Loewenstein and Thompson, 2003; Malhotra and Bazermann, 2008). Neale and Fragale (2006) examined the socio-interpersonal interaction of the negotiators and show the different uncertainties and resulting behaviours in a negotiation.

If then considering negotiations as an abstracted interaction of parties to decide under the influence of complete or incomplete information, game theory offers a model to represent these scenarios in a structured way (Roth, 1991; Samuelson, 2016). Fundamentally, game theory is an established tool to model multiparty interactions on a strategic level and to represent possible outcomes, including aspects such as rationality, individualism, and mutual independence. At the same time, game theory is by no means always the appropriate tool and brings its own weaknesses, for example, in the area of rationality and durability (Romp, 1997).

One of the well-known foundations of game theory was laid by Nash (1951) when he formulated the basic principles of equilibrium in non-cooperative games and postulated that there is always at least one equilibrium where it is not worthwhile for either party to deviate. This remains a central concept in game

theory today. From this foundation and the work of Morgenstern and Neumann, research continued to evolve (Rubinstein, 1995). Today, as in the research on bargaining, sometimes very narrow areas are studied.

For example, Hjaila et al. (2015) investigated the application of game theory in coordinated supply chains compared to scenario-based negotiation approaches. It is shown that the scenario-based variant leads to greater profit expectations.

Based on these considerations, combining the three aspects: healthcare, negotiations, and game theory, the question arises to what extent abstracted strategic models are used to represent the negotiation situations that arise.

Therefore, this research aims to investigate to what extent these models occur in the health literature and are applied and used in real scenarios, especially with negotiations and pharmaceutical pricing from a healthcare professional perspective by using PubMed. The rest of the paper is structured as follows: Section 1.3 describes the methods. Results are presented in Section 1.4. Section 1.5 provides some concluding discussion.

1.3 Methods

In order to ensure a systematic data collection, a literature review was conducted, which was based on the manual for reviews of the Cochrane Collaboration (Wright, 2008). The central question, to what extent game theory is used in healthcare from the perspective of healthcare professionals in negotiation situations, was transcribed into a tool common to this scientific field. A general PICOS scheme was created for related questions, which formed the basis for selecting databases and search terms (See Fig. 1).

P	I. Articles with real-world data & scenarios
	II. Articles with an application of game theory in real-world scenarios
I	I. Use of negotiation strategies
	II. Application of game theory in negotiations
C	I. Application of game theory
	II. Application of game theory in price negotiations
O	I. Ratio of literature & area utilization
	II. Ratio of literature & financial utilization
S	I. + II.: All scenarios with real-world data in the healthcare sector from a healthcare professional perspective

Figure 1: PICOS of the scenarios I and II for the literature search of the overview - Use of game theory in real negotiation strategies (I) & application of game theory in price negotiation scenarios (II) - from a healthcare professional perspective.

The PICOS resulted in the following inclusion and exclusion criteria for the search:

Inclusion	**Exclusion**
Published between 01.01.2004 - 31.03.2019	Textbook literature
Language: English	Abstract only
Literature type: all	
Strategic interaction	
Health-related scenarios	
Application or applicability	
Available as full text	

Table 1: Inclusion and exclusion criteria for the literature search of the overview.

In order to take the perspective of healthcare professionals into account, PubMed (Shariff et al., 2013) was chosen as one of the central and freely accessible

platforms in healthcare research. In addition, the German life science search portal LIVIVO (Müller et al., 2017) was used.

Search operators were formed using the PICOS scheme and the inclusion and exclusion criteria, and all the results thus obtained were screened. For this purpose, all results were randomized in blocks of one article each, checked against the criteria and for duplicates, and a control group also checked 50 % of the blocks.

Subsequently, the results obtained for research topics on game theory were categorized in general terms: *Administration; Biochemistry; Caregiver; Disease Management; E-Health; Gamification; Hospital; Patients; Healthcare Professionals; Resource Allocation; Vaccination*.

The data thus obtained were evaluated and contrasted in the final analysis.

1.4 Results

A total of 1168 documents were found, of which 372 duplicates were excluded. 796 full-text articles were reviewed using the PICOS and the inclusion and exclusion criteria. Game theory was used in 126 cases, whereas research on negotiation situations only occurred in 109 cases. In five cases, the areas overlapped, and game theory was considered in a negotiation-related context, of which three were directly related to price negotiations (see Fig. 2).

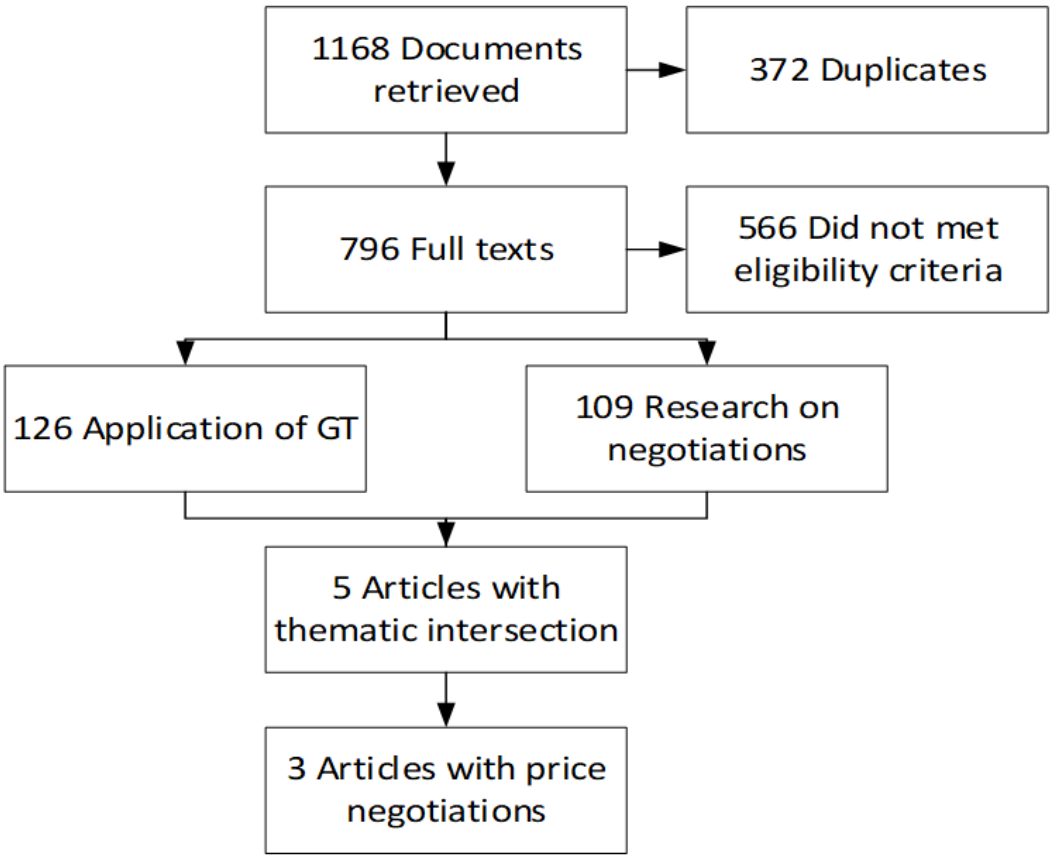

Figure 2: Flowchart indicating screening process results of the found literature.

The 126 cases in which game theory was used in the concept can be divided into the following categories: *Administration; Caregiver; Disease Management; E-Health; Gamification; Hospital; Patients; Healthcare Professionals; Resource Allocation; Vaccination*. *Resource Allocation* is the most frequent category with 20 cases. In 13 cases, *Vaccinations* are considered, while the third most frequent category is *Administration* in ten cases. 46 cases are not assigned to any category or are grouped as "Other", due to single mentions and too distinguished subject matters. A full listing of all results of application of game theory (126 cases) – as well as a clustering and summary – is available in the Appendix.

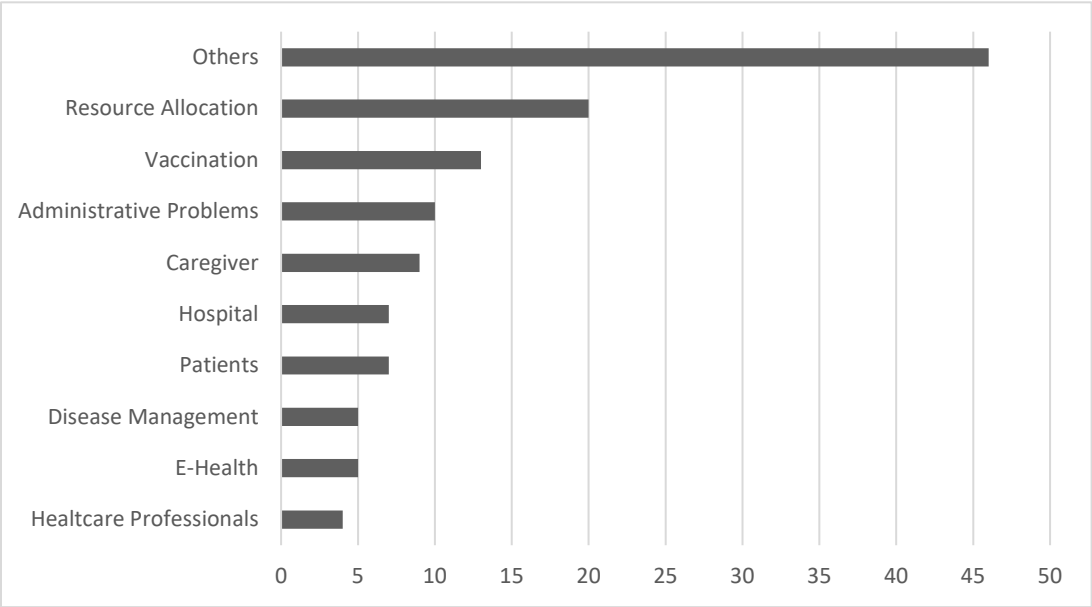

Figure 3: Topic distribution of literature findings - assigned to categories.

Looking at the three largest categories, one of those categories includes the *Resource Allocation* on an individual as well as on an administrative level.
E.g.:

- Development of the extensive form of a sequential game whether high or low risk organs should be transplanted (Skaro et al., 2015).
- A game-theoretical approach, which predicts a decline in drug quality, in case of an introduction of a citizen insurance (Nguyen and Rolf, 2012).

In the second largest category, almost the entire literature found deals with models for acceptance and coverage of *Vaccinations*, if one excludes the development of vaccine sera from a biological perspective.

E.g.:

- Due to herd immunity, a strategic interaction between individuals also arises from the nature of their decision (Bauch, 2005).
- The interests of the public are weighed against the interests of the individual, with the discrepancy increasing as the cost of vaccination increases (Shim et al., 2012).

The third presented area covers the *Administrative Problems*, as well as legal peculiarities in the administration of the health sector.

E.g.:

The representation of mergers and acquisitions as simple prisoner dilemma. The emerging problems at the level of work culture are represented here by basic models of game theory. However, game theory only serves as an abstract model for simplification (Creasy and Kinard, 2013).

Overall, a diverse picture of interaction scenarios in the health care industry in which game theory was used emerges. However, only five cases were found in which these approaches were applied to negotiation scenarios. Of these, only three were related to price negotiations or prices in general. Game theory models were partly used for a retrospective view, as in the following examples.

Harris et al. (2016) show that retrospectively the value-based funding of drugs in Australia corresponds to the game theoretical models used for this purpose. It is assumed that evidence-based assessment of the value of medicines would lead to a restriction of availability in relation to the bargaining power of the government and the pharmaceutical companies. This was tested using a simple bargaining model and regression analysis over the years 1993-2009, using submissions and resubmissions with an assumption of superiority. Funding is found to become more likely over time and with falling prices, as well as depending on the severity of the disease and the quality of evidence available. Overall, as the strength of bargaining power increases, the likelihood of funding increases.

Wright (2004) presents the Australian pharmaceutical market, which regulates the price consumers pay as a multi-stage game between regulators and pharmaceutical companies. The Australian pharmaceutical benefit scheme is converted into a theoretical model, where strategic interactions and bargaining between the key stakeholders, pharmaceutical companies and regulators are the main aspect. It was presented as a five-stage game, with stages ranging from entering the regulation process – determination of drug quality – regulators choice of the company – price negotiation - to market competition in different quality from other companies after the regulation process. In this proposed scenario it is always beneficial for a high-quality company product to enter the regulation process, whereas low quality company products will generate no sales from the

process, thus not relocating customers from the high-quality product. In general, efficiency implications to the regulation system are made, that a single regulated price is sufficient if it is chosen with efficiency and equity in mind.

Ramani and Urias (2015) investigated the influence of compulsory licenses on drug negotiations. Their study is based on developing countries dependent on foreign companies for supplies. A model of negotiating a price drop with the option to use compulsory licensing between two players was analysed. They determined three overarching driving factors of issuing a compulsory license: Manufacturing capacity, import possibilities and retaliation from developed countries. Those factors influence heavily the bargaining power. Thus, the potential threat of a compulsory licensing and its factors should be utilized in maximizing the own bargaining power and supporting a long-term approach. A compulsory licensing is only usable as a short-term problem solution.

In a study about healthcare system price inflation, different pricing frameworks, autonomously priced fee-for-service and cooperative modified pricing and incentive strategies, in the field of medical devices were compared by Agee and Gates (2013). Community-level provider and insurer data was used to compare the respective costs. In the alternative framework, the management of outpatient and inpatient claims were distributed between provider and insurer. They find that consistent with game theory predictions about cooperative behaviour, the cooperative framework benefits all participants by lower administrative cost and increased margins.

Knight et al. (2017) analyse the throughput and its optimization in hospitals by modelling the critical care unit interaction between hospitals in a game theoretic framework. The effect of targeted policies for utilization values in the United Kingdom were researched with a normal form game underlined with a two-dimensional continuous Markov chain. It is shown that, if the capacity is not sufficient, rational behaviour can lead to a damaging effect on patient throughput.

In summary, it appears that among all articles found, only a fraction deals with game-theoretic models of negotiation and price bargaining.

1.5 Concluding remarks

Overall, this research shows that a variety of topics are linked to game theory on PubMed and that there are different approaches to use them to represent existing processes.

However, in relation to the relevance of various negotiations in healthcare, game theory approaches are rarely used to obtain a better understanding of the underlying incentive structures. This is also clearly illustrated by the relationship in numbers between data-driven research versus game theory-driven research in this study.

It should be noted that this review only takes the perspective of a healthcare professional who uses PubMed or LIVIVO as an initial search tool.

Therefore, it is not possible to say conclusively whether the low usage is due to the specifics of the subject area and database or whether this is a potentially useful gap in the research that needs to be filled.

Chapter 2: Drug assessments are affected by the presentation of the data

Yvonne-Beatrice Böhler

Faculty of Applied Natural Sciences, TH Köln

Philipp C. Wichardt

Dept. of Economics, University of Rostock;

Kiel Institute for the World Economy; CESifo Munich

Felix Wolfrum

Faculty of Applied Natural Sciences, TH Köln;

Dept. of Economics, University of Rostock

2.1 Abstract

Objectives

The present study considers the question how the assessment of new drugs is affected by the presentation of statistical key data regarding the efficacy of the drug (*Tabular* vs. *Text* and *Percentage* vs. *Frequency*).

Methods

A questionnaire study asking subjects to assess a new drug relative to an appropriate comparator was conducted. The study used eight different treatments differing in the illness addressed (*Plaque Psoriasis*; *Prostate Cancer*) and the presentation of the data (*Tabular* vs. *Text* and *Percentage* vs. *Frequency*).

Results

1200 student subjects participated in the study. The data show a significant improvement in the rating of the new drug once information is presented in tabular form. By contrast, no general distinction can be established between *Percentage* and *Frequency*. However, once we focus on the presentation as *Tabular*, the evaluation of the new drug improves further if the information is presented using percentages.

Conclusions

The study shows that presenting (favorable) data for a new drug in a *Table* rather than in *Text*, leads to a significantly better rating. Obviously, the way the data are presented entails no fundamental information about the value of the new drug. Thus, the observed differences not only highlight an apparent framing effect. They also emphasize an important potential bias in evaluations in case statistical information are not presented in a coherent way once official drug assessments are made.

2.2 Introduction

Every year there are numerous new medicals introduced to the market. Before these are licensed by local authorities and prices are set, however, they first must undergo some assessment procedure in order to establish that they indeed have an added benefit compared to existing comparators. In this process, data about the effectiveness and side effects of the new drug are assessed and compared to an appropriate comparator therapy (see Appendix B.1 and IQWiG (Institute for Quality and Health Care) 2019 for a description of the process in Germany). The joint federal committee decides, based on the available information, whether the new drug has an added benefit and can thus be better priced in the price negotiations by the manufacturer. Ideally, the drug benefit assessment follows a rational process (Vogler et al., 2015; Vogler et al., 2018). Yet, it is a well-known fact that decisions in general are often subject to various biases (see Camerer, 2003).

In the present paper, we focus in particular on effects related to the presentation of the data. As pointed out by Gigerenzer and colleagues (e.g., Hoffrage et al., 2002; Gigerenzer et al., 2011a; Marewski et al., 2012), people tend to have difficulties interpreting probabilities, especially when these are not provided as information about *Natural Frequencies*. Adding to this literature, All et al. (2011) also demonstrated that *Natural Frequencies* are better understood than percentages concerning diagnostic testing procedures. Today, the corresponding effect is also referred to as "statistical illiteracy" (Gigerenzer et al., 2007; Gaissmaier and Gigerenzer, 2008; Operskalski and Barbey, 2016; Wegwarth and Gigerenzer, 2017).

We take up the discussion about the effects of different presentations of statistical effects. We set up a questionnaire study (n=1200) in which we present data for two new drugs (*Plaque Psoriasis, Prostate Cancer*) and vary the way the data is presented (*Tabular* or *Text*; *Percentage* or *Frequency*). The data presented are taken from actual early benefit assessments processes in Germany (GBA, 2019a, 2019b). Once the data are presented, subjects are asked about their evaluation of the new drug compared to the existing one.

The data show that there is a significant improvement in the evaluation of the new drug if the information about its benefit is provided in a table rather than in text. However, no general effect is found once we compare frequencies and percentages. Yet, if we focus on the presentation of the data in a table, the

evaluation of the new drug improves further if the information is presented using percentages.

It is beyond the scope of this paper to adjudicate on the question of which type of presentation is best. For this, we would need to know what "the correct" decision on the respective drug would be - which of course we don't. However, from a policy point of view it seems clear that the presentation of the data itself is less innocuous than what it might seem.

The rest of the paper is structured as follows: Section 2.3 describes design of the questionnaire. Results are presented in Section 2.4. Section 2.5 provides some concluding discussion.

2.3 Design and procedures

The study was conducted as a questionnaire study querying students at different universities in Germany. In total, 1200 participants took part in the study (mean age 22.2 years; 62.1 % female; 82.6 % statutory health insurance), each of them being randomly assigned to one of eight treatments. In addition to the different treatments, some basic sociodemographic and health data were collected.

Each questionnaire contained one of two descriptions of new drugs. The data were each taken from actual early benefit assessments by the German IQWiG (IQWiG, 2013, and IQWiG, 2019b) both for the drug and the appropriate comparator therapy. In one case, the treatment was for *Plaque Psoriasis* (IQWiG, 2019b); in the other, it was for *Prostate Cancer* (IQWiG, 2013). The presentation of the cases in the questionnaire was simplified so that the information provided was understandable for laypersons. In the questionnaire, the disease's primary features were provided, and the test persons were each presented with an old and a new drug and their core variables.

Regarding our treatment, we varied the presentation of the data. Information regarding the core attributes of the drug was provided either in *Text* or as a *Table* and using *Percentages* or *Natural Frequencies*, i.e., for both cases we used a 2 x 2 variation. In case of *Plaque Psoriasis*, the variables presented referred to: D*ecrease in Severity, Decrease in Itching, Decrease in Redness, Decrease in Pain, Decrease in Burning, Increase in Quality of Life* and *Side Effects Experienced*. For the scenario

with *Prostate Cancer*, the following variables were presented: *Overall Survival*[1], *Level of Pain, Physical Well-Being, Social-Wellbeing, Emotional Well-Being, Side Effects* and *Serious Adverse Events*; see Appendix A for details.

Once the respective case was described, subjects had to indicate which drug they see as superior, old or new. Using a forced-choice question technique, subjects rate the amount of benefit, ranging from 1-4 for the old or new drug. This information was asked in five dimensions: *Level of Tolerance of the Drug*, *Increase in Quality of Life*, *Reduction in Pain*; *Efficacy*; *Subjective Rating*. Moreover, subjects were asked whether they saw an *Advantage* in the new therapy and, if so, how strong this *Advantage* was rated on a scale from 1-10. Finally, subjects were asked if they would use the new drug as a patient. A summary of the planned questionnaires is provided in Figure 4 below.

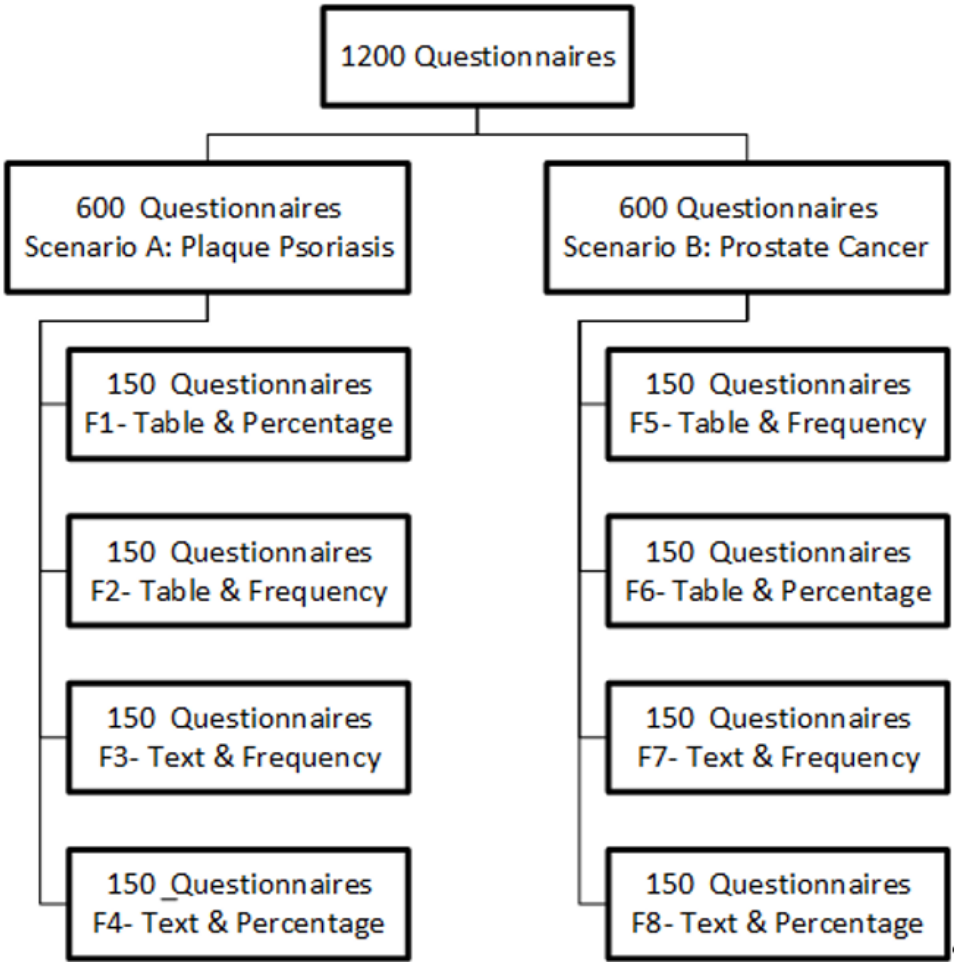

Figure 4: Treatment distribution for data presentation influences on drug perception study.

[1] [% patients over study time]

2.4 Results

A total of 1021 of 1200 sheets were evaluated. The missing questionnaires were either incomplete or not returned at all. Figure 5 below provides a summary of response frequencies.

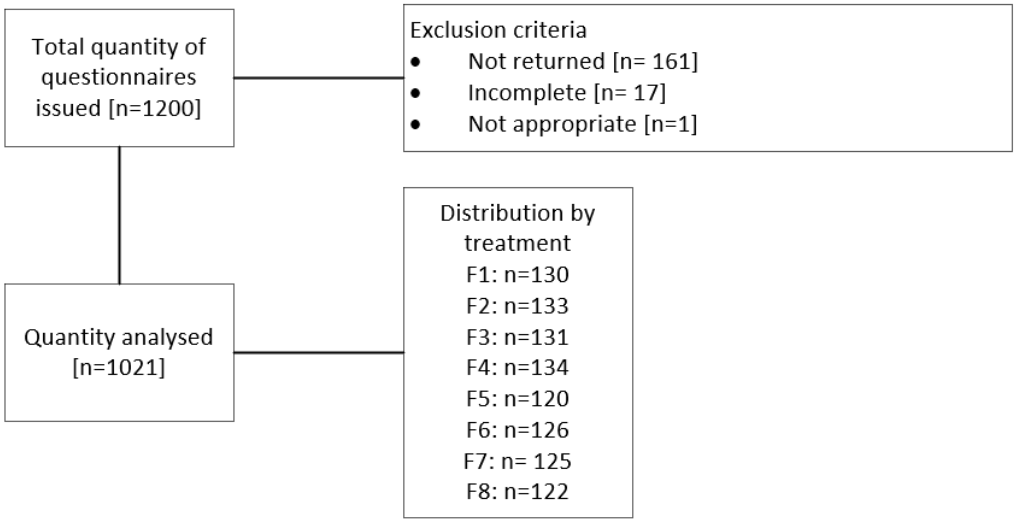

Figure 5: Response frequencies of study participants.

	Overall	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**
Age (Mean)	22.2	22.8	22.4	22.3	22.9	22.0	21.8	22.0	21.8
Sex (% Female)	62.1	58.1	49.2	54.6	46.2	74.2	72.2	72.8	70.5
Insurance Status (% SHI)	82.6	91.5	88.7	87.0	92.5	76.7	71.4	79.2	73.8

Table 2: Summary demographics of the study, where F1-F4 is scenario A and F5-F8 is scenario B. Differences can be explained by different course of study. Scenario A mostly medical students and Scenario B mostly chemistry students.

For the analysis, one variable was constructed from the five dimensions that had to be assessed. In doing so, the scale range was converted to 1-8, where one is the maximum benefit for the old drug and eight for the new drug. Following these values were added up and the mean over all dimensions was used; see Table 3 below.

Questionnaire/ scenario	Summarized mean drug ratings	Tolerance	Quality of life	Pain reduction	Efficacy	Subjective rating
F1 (Table; Percentage)	34.2	6.4	6.8	7.0	6.9	7.11
F2 (Table; Frequency)	32.2	6.2	6.5	6.4	6.5	6.5
F3 (Text; Frequency)	32.8	6.1	6.5	6.8	6.7	6.7
F4 (Text; Percentage)	33.0	6.2	6.8	6.8	6.7	6.6
F5 (Table; Frequency)	23.1	4.3	5.7	4.3	4.5	4.3
F6 (Table; Percentage)	22.1	4.2	5.4	4.2	4.2	4.2
F7 (Text; Frequency)	20.9	3.9	5.0	4.0	4.1	3.9
F8 (Text; Percentage)	2.5	3.6	4.9	4.0	4.1	3.9

Table 3: Summarized ratings of the effect on drug assessment: In terms of totals, the percentage presentation in scenario A and the tabular presentation in scenario B lead to a preference for the new drug.

The first thing to note is that a presentation of the data in *Tabular* form always shows the highest summarized mean scores in each scenario, which can be seen in Table 3. Moreover, further analysis shows that a presentation of the data in *Tabular* form with *Percentages* is best in scenario A. In scenario B this difference is not significant. Yet, a presentation in *Tabular* form again is strictly better; cf. Table 2.

All in all, the data show that a new drug, which is better than the existing comparator according to the available data, is rated more superior if the data are presented (and compared) in a *Table*; in scenario A, a further improvement occurs if *Percentages* are used instead of *Natural Frequencies*.

When the data are presented textually, there is no significant difference when the numbers are presented as frequencies or percentages.

Compared questionnaires	Sum p-Value
Scenario A: F1 (Table; Percentage) vs. F2 (Table; Frequency)	0.0035
Scenario A: F1 (Table; Percentage) vs. F3 (Text; Frequency)	0.0117
Scenario A: F1 (Table; Percentage) vs. F4 (Text; Percentage)	0.0266
Scenario A: F2 (Table; Frequency) vs. F3 (Text; Frequency)	0.7801
Scenario A: F2 (Table; Frequency) vs. F4 (Text; Percentage)	0.8647
Scenario A: F3 (Text; Frequency) vs. F4 (Text; Percentage)	0.6406
Scenario B: F5 (Table; Frequency) vs. F6 (Table; Percentage)	0.3147
Scenario B: F5 (Table; Frequency) vs. F7 (Text; Frequency)	0.0002
Scenario B: F5 (Table; Frequency) vs. F8 (Text; Percentage)	0.0000
Scenario B: F6 (Table; Percentage) vs. F7 (Text; Frequency)	0.0301
Scenario B: F6 (Table; Percentage) vs. F8 (Text; Percentage)	0.0003
Scenario B: F7 (Text; Frequency) vs. F8 (Text; Percentage)	0.2780

Table 4: Result of hypothesis testing on average drug ratings – sets compared.

Furthermore, the subgroup's gender (m/f), age (≤ 21/ > 21) and risk propensity (1-5/ 6-10) were analyzed grouped by scenario. There was a correlation in scenario B in the evaluation by gender ($p = 0.0009$). Women rated the new drug better in the cumulative result (1.7 points). However, it should be noted that the male sample was disproportionally small with 27.4 %. Overall, no differences in behaviour can be observed in the evaluation according to subgroups.

Scenario	Gender	Age	Risk propensity
A	0.7103	0.1466	0.6990
B	0.0009	0.2161	0.9679

Table 5: Subgroup analysis of differing evaluation behaviour regarding the summed mean drug rating.

In addition to the questionnaire analysis, a comprehensive descriptive analysis of the GBA and IQWIG databases and the associated specialist information from pharmaceutical companies was carried out. Comparing the reports for the individual cases revealed a deviation in the frequency of the presentation forms used between the three institutions. The documents were scanned, grouped, and the respective sub-items summed up in a table. It can therefore be assumed that a consistent presentation is not used across institutions; seen in Table 6.

Actor	**Table**	**Text**	**Graphic**	**Mixed**
GBA	49.2 %	42.6 %	5.1 %	3.1 %
IQWiG	53.6 %	44.2 %	1.9 %	0.3 %
Pharm. manufacturer	40.7 %	51.2 %	8.1 %	0.0 %

Table 6: Variation of data representation across institutions in Germany.

Summing up, the results of our study show that the presentation of the available data has a significant impact on the evaluation of the relative performance of a new drug. In particular, the presentation of favorable data in a *Table* (compared to a *Text*) leads to considerably better assessments.

Naturally, we cannot say whether a presentation of the data in a *Table* itself is "better", as this would imply that we had an objectively measured parameter for the comparisons. This, obviously, is not the case. Yet, it seems that a presentation which renders it easier for the subjects to visually grasp the core information induces a stronger differentiation between the new and the old drug.

2.5 Concluding remarks

In the present study, we have compared different ways of presenting data regrinding the efficacy of a new drug regarding the assessment of the drug in relation to an existing comparator. As we have seen, using a *Tabular* design led to a shift for a better rating of the newer drug (a combination with a presentation of the data using *Percentages* instead of *Natural Frequencies* may further increase the differences).

Obviously, the assessment of a new drug is a vital component, especially in medical professions. Accordingly, distortions caused by framing effects are important to understand in order to avoid intentional manipulations of advisory boards. While we cannot say which kind of presentation does most justice to the presented information, it seems reasonable for any repeated decision routines that deal with the comparison of different medicals to require a standardized format for statistical information. While this will not avoid biases in general, it will at least allow decision makers to get used to the standardized format thereby enabling them to make judgements which are more comparable than in the case where different assessments rely on different formats.

Chapter 3: Frequent complete rejection of risk in domain-specific risk questions may be caused by fear

Fynn Kemper

Dept. of Economics, University of Rostock

Philipp C. Wichardt

Dept. of Economics, University of Rostock;

Kiel Institute for the World Economy; CESifo Munich

Felix Wolfrum

Faculty of Applied Natural Sciences, TH Köln;

Dept. of Economics, University of Rostock

3.1 Abstract

There are various question formats to empirically determine risk attitudes. Among them is the general risk question and its domain-specific variations, which ask about risk attitudes in the areas of *Financial Matters, Car Driving, Sports and Leisure, Career, Health* and *Trust in other People*.

Although the wording of the domain-specific questions is very similar to the general risk question, the distributions of answers exhibit some considerable differences. We illustrate these differences using the SOEP and discuss possible causes. In particular, the answer option "0", representing "*not at all willing to take risks*", occurs significantly more often in the domain-specific risk questions than in the general risk question. The consequence for research is that domain-specific and general risk questions are not directly interchangeable in their application but require consideration of their systematic differences.

Furthermore, the emotion fear seems to have an influence on the tendency

to tick ″0″ in the domain-specific risk questions.

Keywords: Risk preference; domain-specific risk preferences; fear; SOEP

JEL codes: D80; D81; C90

3.2 Introduction

Risk preferences is a frequently discussed topic in economics. Over a long period of time, it was approached on the assumption of the utility function (Arrow, 1964; Arrow, 1996). Empirically, there are two major approaches to determine the risk preferences of subjects, that are used today. The revealed preferences approach tries to deduce the risk preferences from observed behaviour. An example for this is the lottery-based design of Holt and Laury (2002). Compare also Lejuez et al. (2002), Figner et al. (2009) and Crosetto and Filippin (2013). The other approach is the concept of stated preferences, for example a multiple domain questionnaire method as described by Dohmen et al. (2011), which was used here in the format of the SOEP panel as a data source. Wichardt et al. (2013) found that measures correlated only, if at all, very weakly with each other. Furthermore, a test-retest stability is nearly exclusive in the questionnaire approach. Furthermore, Charness et al. (2013) also state that there is no standard measurement procedure regarding risk preferences and the statements made are therefore only valid in their respective area without restrictions. Dohmen et al. (2011) also align with this and state that the influence of age, gender and parental background has an impact on willingness to take risks.

Overall, this indicates that the observation of risk preferences is linked to external factors and that an examination of the risk measure without a more complex representation of the accompanying parameters is of limited value. Taking this further, if we look at individual risk preferences in different domains, it is shown according to Einav et al. (2012) that a domain-specific variable (in this case: Insurance domains like dental or health) has a strong influence on those but varies in strength between different domains. The assumption that a specific change in question wording leads to a different behaviour is also shown in the experimental findings of Loftus and Palmer (1974), as well as Loftus (1975). Both studies show that a changed wording in a question leads to a different assessment of the situation (estimated speed in described traffic situations e.g.: “bumped” vs “smashed”). All this indicates that the specificity of the question influences the obtained result through the questionnaire. We suspect that this is triggered by a direct visual imagination of a risk situation. Moulton and Kosslyn (2009) also give support to this hypothesis.

In this study, we focus on the assessment of the risk preferences by means

of the SOEP data from 2004 to 2014, as the risk questions we are interested in were only included in those years.

A detailed look on the distribution of risk preferences in the specific domains (*Car Driving*; *Health*; *Career*; *Financial Matters; Sports and Leisure*; and *Trust (in others))* reveals that "0" is always overrepresented in those compared to the *General* domain.

Considering possible factors influencing people's risk behaviour, the link between risk and fear immediately emerges. This was proven in a meta-analysis of 50 studies by Wake et al. (2020). According to the clinical definition, fear is a cross-cultural primary emotion with psychological and physiological symptoms, like restlessness and increased pulse, as well as perceptual and thought impairments (Pschyrembel, 2020). Therefore, it is reasonable to assume that the psychological effects of fear could lead to a change in risk behaviours. The previously mentioned meta-analysis of Wake et al.[2] (2020) proves a significant influence of fear on risk-taking. Further fear lowers the preference to take risks, which is also shown in other studies (Raghunathan and Pham, 1999; Lerner and Keltner, 2001; Niedenthal et al., 2006; Charpentier et al., 2017;). Thus, we hypothesize that for our analysis an increased tendency to fear should lead to an increased propensity to state risk "0". This is consistent with the general findings mentioned above. Gerdes et al. (2009) as well as Pittig et al. (2013) also indicate that a fear-relevant acute stimulus can lead to avoidant behaviour (see also Gerdes and Alpers, 2013).

Maner and Schmidt (2006) additionally show that inherent fear leads to risk-averse behaviour, through an increased assumption of a negative incident in probability and severity. This link is confirmed by Giorgetta et al. (2012). In the case of financial decisions, this is also confirmed by the results of Lee and Andrade (2019).

Kuhnen and Knutson (2005), and Hartley and Phelps (2012) show on an anatomical level that different behaviour (related to fear and risk) also leads to different activities in the functional areas of the brain.

Therefore, we investigate in this paper that the above-mentioned influence

[2] Wake et al. (2020) also address the different nomenclature and distinction between fear and anxiety, since no significant difference (regarding risk taking) was found between the two terms, both terms are to be considered synonymous in this paper.

effects of fear and specificity of the question affect the answers given in the SOEP panel on risk taking.

The remaining sections are structured as follows: Section 3.3 describes the data used. Section 3.4 follows with a description of the anomaly found. Section 3.5 shows the analysis and the results. Section 3.6 addresses the question whether answer "0" is to be considered as not applicable and Section 3.7 ends with a general conclusive summary.

3.3 Data

The data basis is the SOEP. This involves repeated surveys of around 22,000 German households every year (DIW Berlin, 2021). The questions cover general demographic data as well as a detailed breakdown of the household members' living situation. For our study, the questions on risk preferences are particularly relevant.

The participants' risk preferences were considered in seven domains in the SOEP (in the respective waves 2004, 2009 and 2014) and measured on an 11-item Likert-scale ranging from "0 – not at all willing to take risks" to "10 – very willing to take risks." The belonging domains respectively variables are *General*, *Financial Matters*, *Car Driving*, *Sports and Leisure*, *Career*, *Health* and *Trust* (*in others*). Questionnaires with no given answer in the general as well as the domain-specific risk questions were excluded.

Since we are especially interested in the answer option "0" regarding risk preferences, we construct seven dummy variables from the seven variables from the respective risk questions. They take the value 1, if a (domain-specific) risk preference of "0" was stated, and 0 if a risk preference greater than "0" was stated in that domain. For the simplicity of notation, we will refer to them as the "*Dummy on… (the respective domain)*".

Further variables are *Fear*, *Female*, *Age*, *Abitur: Mother* and *Abitur: Father*. *Fear* was measured on a five item Likert-scale by how often the individual has experienced fear in the past four weeks in the years 2007, 2009 and 2014. Since the question about *Fear* was not included in the 2004 SOEP wave, we used the data from the 2007 wave instead for the construction of *Fear* and matched those data to the other data of the 2004 wave. Possible answers to the question about fear were "very seldom", "seldom", "sometimes", "often" or "very often". *Female* is a

dummy variable representing the individual's gender and takes the value 1 for females. "*Abitur*" is an exam that is a prerequisite for attending university. The dummy variables "*Abitur: Mother"* and "*Abitur: Father"* were also used by Dohmen et al. (2005) to account for the parents' educational level. They take the value 1 if the respective exam was passed by the respective parent.

Overall, this leaves us with 70,026 observations. Note, that data on a specific individual may be observed in each of the three waves, so that there may be up to three observations per individual. While the descriptive analysis initially ignores this fact, it will later be considered in the panel analysis.

3.4 On the anomaly

Figures 6 and 7 show exemplarily the comparison of the response distributions between the general risk question and the one in the domain of *Career*. The other domain-specific risk questions exhibit a similar pattern in the response distribution compared to the one in the domain of *Career*. They are shown in Figures 3-6 in the Appendix**.** All distributions show a (slight) clustering at the middle of the scale - risk class 5. This is not surprising, since focal points such as the mean values of Likert-scales are generally chosen more frequently (Greenleaf, 1992). However, the main observable difference refers to risk category "0". While category "0" does not particularly stand out from a bell shape for the general risk question, it represents the modal value for all domain-specific risk questions. In order to describe the characteristics of the distributions in more detail, we point out the following additional features: Apart from focal points "0", "5" and "10", the next most frequent responses are categories "2" or "3". Furthermore, again excluding focal points, response frequencies strictly decrease with increasing distance to classes "2" or "3" the only (minor) exception to this pattern is class "7" for *Career*. Both the general and all domain-specific risk questions show this pattern. The only major difference that we recognized by simply looking at the response distributions relates to the response frequencies in the category "0". According to a z-test the pairwise differences in the propensity of "0s" between the dummy on *General* and each single dummy on the domain-specific risk questions are statistically significant at all reasonable levels ($p < 0.001$). We discuss this difference in the further course of this paper in more detail.

It could be that individuals answer the risk questions in two different modes. Either they give a realistic answer (and try to assess their actual risk preference in an economist's sense), which actually might be "0", or they do not mentally deal with the concept of risk preference and see the answer category "0" as a blanket rejection of risk in the specific domain. The latter mode could also be described by the dogma "safety first", such that all kinds of risks are to be avoided — independent from the benefits that may be at stake[3].

Kahneman (2011) describes that people sometimes do not answer the actual question but instead a similar and simpler question. In the domain of *Career* this could be something like "Are you willing to lose your job?", which is instantly answered with "No!", such that "0" seems to be the appropriate answer on the 11-item Likert-scale. *Car Driving* could be associated with a car accident, *Health* with getting sick and so on. In contrast, the general risk question is a more abstract question and concrete undesirable scenarios may not come to mind as easily. The more specific the question is, the more specific is presumably the scenario imagined (cf. Moulton and Kosslyn, 2009). This would then result in structural differences in the response distributions between the general and the individual domain-specific risk questions – the basic shape would be the same with the major exception that category 0 is significantly more prevalent in the domain-specific risk questions than in the general one; whose confirmation Figure 6 at least suggests.[4]

[3] Pittig et al. (2014) indicate that the occurrence of fear hinders rational decision making. In our case, the probability of a car accident would then not be offset against the potential time savings from speeding.

[4] It should be noted that although the individual distributions look quite similar, their means and variances differ pairwise with a few exceptions. The means of *Sports and Leisure* and *Career* are not statistically different (t-test, $p = 0.2709$); furthermore, the variances of *General* and *Trust* ($p = 0.351$) and *Sports and Leisure* and *Car Driving* ($p = 0.0038$) are not statistically different on all reasonable levels according to Stata's variance-comparison test. All other comparisons are significant on any reasonable level. However, equality of the distributions is not necessarily to be expected, since different concepts are queried by the individual domain-specific risk questions.

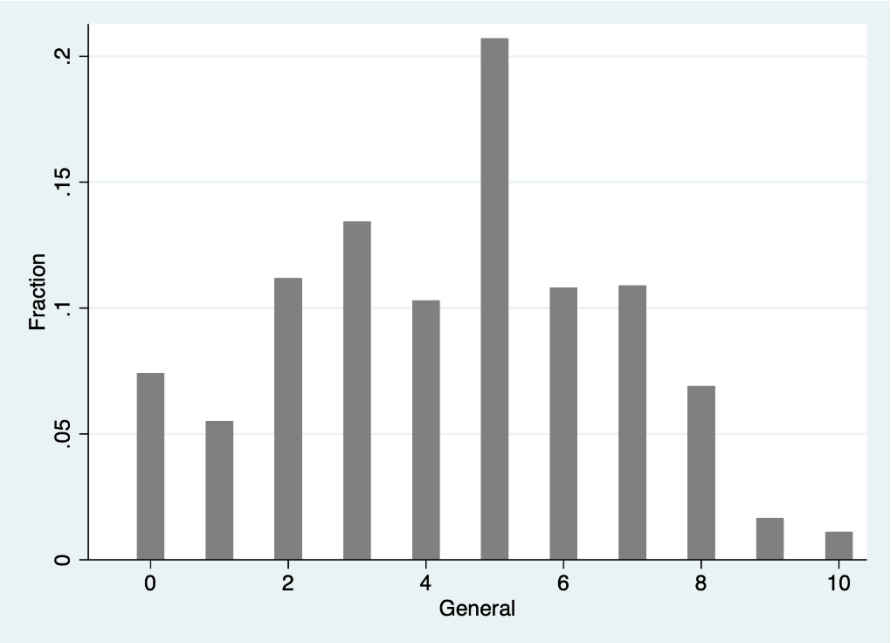

Figure 6: General risk preference – distribution.

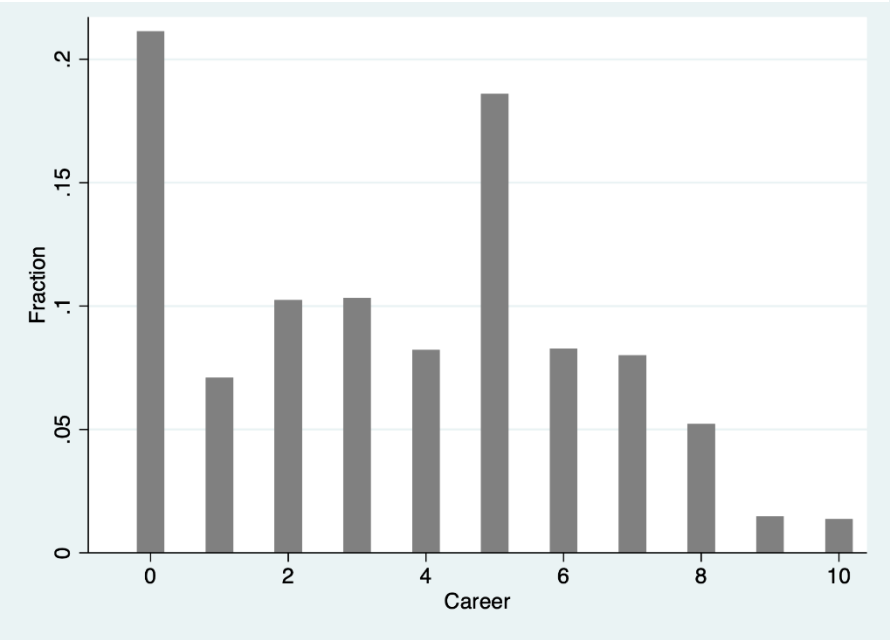

Figure 7: Career risk preference – distribution.

Figure 6 and 7: Apart from the clustering at "0", the distributions seem to be quite similar. The distributions of the risk preferences in other domains can be found in the Appendix — they show a very similar pattern compared to the *Career* domain.

3.5 Analysis and results

3.5.1 Descriptive analysis

However, as already stated in Section 3.4, the pairwise differences in the propensity of "0s" between the dummy on *General* and each single dummy on the domain-specific risk questions are statistically significant at all reasonable levels. Table 7 presents those proportions. *General* exhibits a lower proportion of category "0" than each of the domain-specific variables.

Result 1. *Category "0" is more frequently chosen in the domain-specific risk questions than in the general risk question.*

The six domains belonging to the domain-specific risk questions are supposedly chosen to cover a large part of everyday life. Assuming that no other important domain is missing and without further considerations, one could assume that the responses on the general risk question could be derived from the ones on the domain-specific questions as a weighted mean with the sum of weights being equal to 1. However, since the mean of *General* lies outside the range of the domain-specific risk questions' means, this is not possible. All domain-specific risk questions' means are generally lower than the mean of *General,* which is illustrated in Table 7. This may be simply due to the fact that in the domain-specific risk questions more individuals are choosing the answer option "0". But also, if only the categories "1" through "10" are considered, *General* still shows the highest mean.

Variable	Observations	Ø	Ø Same Ind.	Share 0 Same Ind.	If answer > 0 Same Ind.
General	69,730	4.36	4.41	7.11 %	5.14
Financial Matters	68,605	2.24	2.30	30.63 %	3.44
Car Driving	65,284	3.17	3.21	22.85 %	4.37
Sports and Leisure	68,639	3.53	3.61	18.53 %	4.72
Career	61,511	3.59	3.60	20.94 %	4.75
Health	69,818	2.98	3.03	21.72 %	4.04
Trust	69,892	3.40	3.41	15.13 %	4.21

Table 7: Overview on the (domain-specific) risk preferences. The confidence intervals of "if answer > 0 Same Ind." are all so small that there are no pairwise overlaps. "Same Ind." refers to the same 58,078 individuals who answered all (domain-specific) risk questions. "If answer > 0 Same Ind." refers to all 30,806 individuals who stated a risk preference of 1 or more in each of the seven risk questions.

Result 2. *The general risk question's mean cannot be represented by a weighted average (sum of weights equals 1) of the domain-specific risk questions' means.*

All seven risk measures are at least moderately correlated with each other (see Dohmen et al., 2005). Not surprisingly, this result relates also to our considered dummy variables regarding the event to tick "0" or not in the respective risk questions. A correlation matrix for the event to tick "0" is given with Table 25 from the Appendix. The correlation coefficients' range is from 0.345 (dummies on *General* and *Financial Matters*) to 0.607 (dummies on *Career* and *Sports and Leisure*). All coefficients are statistically different from 0 at all reasonable levels. This raises the question of which individuals have a particularly high tendency to tick 0 in the risk questions.

Result 3. *The events of choosing category "0" in the general and the domain-specific risk questions are positively correlated with at least medium-sized correlation coefficients.*

Results 1, 2 and 3 give further evidence for a qualitative difference in the answering of the general and the domain-specific risk questions.

3.5.2 Regression analysis

Table 8 shows the probit regression results on the dummy variables of the specific risk domains. Individuals who stated that they had been anxious more often than "rarely" ticked "0" for the domain specific the more often they stated that they had been anxious. But the individuals with "very rarely" fear also ticked 0 more often than those with "rarely".

Domain	(1) Car Driving	(2) Financial Matters	(3) Sports and Leisure	(4) Career	(5) Health	(6) Trust
Fear: very seldom	0.199***	0.309***	0.287***	0.288***	0.289***	0.228***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Fear: seldom	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Fear: sometimes	0.093***	0.073***	0.144***	0.078***	0.075***	0.090***
	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Fear: often	0.231***	0.234***	0.307***	0.247***	0.159***	0.196***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Fear: very often	0.474***	0.478***	0.553***	0.490***	0.501***	0.537***
	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
Risk	0.247***	-0.236***	-0.273***	-0.270***	-0.245***	-0.221***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Female	0.563***	0.333***	0.196***	0.208***	0.264***	0.056**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Age	0.019***	0.007***	0.024***	0.030***	0.011***	-0.001*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Abitur: Father	0.210***	-0.290***	-0.383***	-0.304***	-0.209***	-0.342***
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Abitur: Mother	-0.082*	-0.001	-0.200***	-0.203***	-0.129***	-0.220***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
Constant	1.912***	-0.638***	-1.636***	-1.735***	-1.109***	-0.754***
	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
$\ln \sigma^2_u$	0.159***	-0.096**	-0.063	-0.057	-0.159***	-0.094*
	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
N	48539	50816	50695	44956	51488	51537

*Table 8: Probit estimations on the event to tick 0 (represented as 1 in the respective dummy variables) in the domain-specific risk questions. *: = $p < 0.1$; **:= $p < 0.05$; ***:= $p < 0.01$.*

However, it could be that due to suppression effects, there are also individuals in this category who are particularly afraid, but did not state this "truthfully", whereby this observation does not necessarily contradict the statement that more fear leads to a more frequent ticking of "0" in the domain specific risk questions. Note, that all corresponding coefficients are statistically different from 0.

Result 4. *(Ignoring individuals stating "very rarely") Fear leads to an increased propensity to choose "0" in the domain-specific risk questions.*

With regard to the control variables, it can be seen that across all domains, the general risk question has a significant influence on the tendency to tick "0". The same applies to all other control variables except for *Age* in *Trust* and "*Abitur: Mother*" in *Car Driving* and *Financial Matters*. The results on the "*Abitur*" variables are in line with the findings of Dohmen et al. (2011).

Domain	(1) Car Driving	(2) Financial Matters	(3) Sports and Leisure	(4) Career	(5) Health	(6) Trust
Fear: very seldom	0.242***	0.344***	0.325***	0.308***	0.361***	0.284***
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Fear: seldom	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Fear: sometimes	0.120**	0.055	0.194***	0.057	0.134***	0.194***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Fear: often	0.326***	0.403***	0.420***	0.292***	0.275***	0.370***
	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)
Fear: very often	0.670***	0.618***	0.810***	0.766***	0.957***	0.899***
	(0.15)	(0.13)	(0.14)	(0.15)	(0.13)	(0.14)
Female	0.614***	0.373***	0.253***	0.230***	0.355***	0.148***
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Very seldom*female	-0.073	-0.065	-0.065	-0.037	-0.125***	-0.094**
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
Sometimes*female	-0.045	0.021	-0.079	0.026	-0.096*	-0.163***
	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Often*female	-0.134	-0.234***	-0.162*	-0.065	-0.171*	-0.254***
	(0.10)	(0.08)	(0.09)	(0.10)	(0.09)	(0.09)
Very often*female	-0.262	-0.195	-0.350**	-0.372**	-0.617***	-0.503***
	(0.17)	(0.15)	(0.17)	(0.17)	(0.15)	(0.16)
Risk	-0.246***	-0.236***	-0.273***	-0.271***	-0.245***	-0.221***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Age	0.019***	0.007***	0.024***	0.030***	0.011***	-0.001*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Abitur: Father	-0.210***	-0.290***	-0.383***	-0.303***	-0.209***	-0.341***
	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Abitur: Mother	-0.082*	-0.000	-0.199***	-0.203***	-0.128***	-0.220***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
Constant	-1.383***	-0.330***	-1.475***	-1.540***	-0.902***	-0.754***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
$\ln \sigma^2_u$	0.160***	-0.095**	-0.064	-0.057	-0.157***	-0.092*
	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
N	48539	50816	50695	44956	51488	51537

*Table 9: Probit estimations on the event to tick 0 (represented as 1 in the respective dummy variables) in the domain-specific risk questions. *:= p < 0.1; **:= p < 0.05; ***:= p < 0.01.*

Table 9 provides the results of basically the same regression as in the regressions for Table 8 but adds interaction terms for the variables *Fear* and *Female*. We find some evidence for a moderating effect of *Female* on how fear affects the propensity to tick "0" in the domain of *Trust.* This effect might prevail also in the other domains, but the results are not fully conclusive on this. However, while this result is clear in the domain of trust, the results on the other domains are at least slightly suggestive for females showing a lower sensitivity than men in the effect of *Fear* on the propensity to tick 0. The coefficients for all other variables do not change noteworthy.

Result 5. *At least in the domain of Trust females show a lower sensitivity than men in the effect of Fear on the propensity to tick "0".*

3.6 Answer option "0" interpreted as "not applicable"

It is conceivable that the category "0" of the risk questions' 11-item Likert-scales could also be understood by individuals as "not applicable". In this sense, specific domains are more likely to be inapplicable than the *General* one, because the latter one inevitably affects everyone. This would create a clustering of 0s in the domain-specific risk questions without the actual domain-specific risk preferences having to be different from the *General* ones. We therefore tried to assess the size of this effect.

As shown in Table 10, the number of observations on risk preferences differs between domains. *General*, *Health* and *Trust* have with well above 69,000 the most observations. At the same time those domains are the ones which concern every individual — independent from age, income, job status and other characteristics. *Financial Matters* and *Sports and Leisure* show slightly less than 69,000 observations. Both domains may not seem relevant to individuals with low income or assets as well as bad health or less leisure time. Therefore, it is reasonable that in both domains more missings occurred than in the first three ones. This is supported by the fact, that *Car Driving* and *Career* have the lowest number of observations respectively the highest number of missings, since having access to a car or being in working condition may not be standard. This is some evidence that people may choose not to answer if a certain risk question does not seem applicable to them. Thus, there are individuals that do not provide "0" when the domain does not apply to them.

Both *Car Driving* and *Career* are the only domains which have a considerable amount of missings compared to the frequency of category "0" as a response, which lies at around 20 %. Because the other domains do not show a considerable amount of missings, we conclude that only very few individuals perceived the respective domains as not applicable. At the same time, in those other domains only very few individuals would have been eligible for using answer category "0" as "not applicable". Thereby, we assume that perceiving a question as "not applicable" is one of the main reasons for individuals not answering the risk

questions.[5] So, in *General*, *Health*, *Trust*, *Financial Matters* and *Sports and Leisure* the frequency of response category 0 cannot be explained sufficiently by individuals who interpreted this category as "not applicable".

However, we are able to analyse the applicability of *Car Driving* and *Career* for individuals at least partly. The SOEP enabled us to check for the presence of a car in the household as well as the pension status. Having a car in the household is not equivalent to perceiving car driving as applicable or not. People could have access to a friend's or family's car[6] or they may have a car within reach but do not even have a driver's license. However, it at least has some informative value in terms of applicability. A very similar argument applies to the pension status. There may be pensioners who still have a career as well as people who perceive *Career* as not applicable although they are able to work – i.e., people who voluntarily do not work.

Overall, 14.51% of the individuals in our dataset do not have a car in their household. Of the 4,499 individuals who made no statement in *Car Driving* (which corresponds to 6.8 % of individuals), 52.88 % have no car in their household. Given that no car is available in the household, 23.4 % do not answer the respective question. So, there is a tendency of people without a car in their household to leave out the answer to the risk question in the domain of *Car Driving*.

Pensioners make up 24.5 % of our data set. Of the 8,515 individuals who did not make any statement in *Career* (which corresponds to 12.2 %), 73.66 % are pensioners. 36.6 % of pensioners did not answer the respective question.

Both of these factors suggest that individuals increasingly do not make a statement if the corresponding domain applies to them only to a very limited extent or not at all. So far, there is no reason for us to assume that individuals who do not make a statement have a particularly low or generally deviant willingness to take risks (i.e., they should actually check "0"). On the other hand, for the time being we cannot completely rule out the possibility that the effect we consider in this section will continue to distort the results, although we are fairly certain that it doesn't.

[5] There is no reason for us to believe that individuals in some risk domains may be more reluctant to provide a response for other reasons, such as might be the case in a non-anonymous survey on intimate information.

[6] Car sharing was not a popular option in Germany when our dataset was collected.

For this reason, we also carried out our analyses without the groups for which certain domains are supposedly not so applicable.

An overview of the variables *Car Driving* and *Career* only for the individuals with a car in the household respectively without pensioners can be found in Table 10. The regression results for this subsample are shown in Table 11. The results do not change noticeably.

Variable	**Observations**	**Ø**	**Share 0**	**Ø if answer > 0**
Car Driving (car in household)	54,832	3.30	20.10 %	4.13
Career (pensioners excluded)	50,626	3.93	14.95 %	4.62

Table 10: General overview of the variables Car Driving and Career only for the individuals with a car in the household respectively without pensioners.

	(1)	(2)	(3)	(4)
Domain	**Car Driving**	**Car Driving (with car in household)**	**Career**	**Career (without pensioners)**
Fear: very seldom	0.204***	0.259***	0.324***	0.326***
	(0.03)	(0.04)	(0.03)	(0.04)
Fear: seldom	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Fear: sometimes	0.081***	0.107*	0.036	-0.002
	(0.03)	(0.06)	(0.04)	(0.06)
Fear: often	0.195***	0.304***	0.217***	0.284***
	(0.05)	(0.09)	(0.05)	(0.10)
Fear: very often	0.446***	0.579***	0.423***	0.760***
	(0.08)	(0.17)	(0.09)	(0.17)
Risk	-0.245***	-0.245***	-0.283***	-0.283***
	(0.01)	(0.01)	(0.01)	(0.01)
Female	0.520***		0.247***	
	(0.03)		(0.03)	
Age	0.016***	0.016***	0.015***	0.015***
	(0.00)	(0.00)	(0.00)	(0.00)
Abitur: Father	-0.165***	-0.164***	-0.284***	-0.283***
	(0.04)	(0.04)	(0.04)	(0.04)
Abitur: Mother	-0.104**	-0.102*	-0.186***	-0.187***
	(0.05)	(0.05)	(0.06)	(0.06)
Female		0.582***		0.252***
		(0.04)		(0.05)
Very seldom*female		-0.097*		-0.004
		(0.05)		(0.06)
Sometimes*female		-0.044		0.051
		(0.07)		(0.08)
Often*female		-0.155		-0.089
		(0.10)		(0.12)
Very often*female		-0.184		-0.441**
		(0.19)		(0.20)
Constant	-1.830***	-1.349***	-1.343***	-1.098***
	(0.07)	(0.05)	(0.07)	(0.06)
$\ln \sigma^2_u$	0.044	0.045	-0.147**	-0.147**
	(0.05)	(0.05)	(0.07)	(0.07)
N	41636	41636	36361	36361

*Table 11: Probit estimations on the event to tick 0 in the specific subgroups variables Car Driving and Career compared with Car Driving and Career only for the individuals with a car in the household respectively without pensioners (represented as 1 in the respective dummy variables) in the domain-specific risk questions. *: = p < 0.1; **:= p < 0.05; ***:= p < 0.001.*

3.7 Concluding remarks

We reveal that risk preference of "0" is more frequently reported in the domain-specific questions (on *Financial Matters*, *Car Driving*, *Sports and Leisure*, *Career*, *Health* and *Trust)*. Thus, the average of the general risk question can never be represented by weighted averages of the domain-specific questions. In addition, we find that there is a positive correlation between the general and domain-specific risk questions for the propensity to state "0". Hence, it can be concluded that there probably is a qualitative difference in the answers to the general and domain-specific risk questions. This also corresponds with the results of Einav et al. (2012) that the specificity of the domain influences the response.

Fear is another individually inherent factor that also significantly increases the propensity to state "0". Provided that the statement "very seldom" is ignored. The effect of increased propensity to state "0" and the influence of *Fear* is consistent with the results of Wake et al. (2012).

From this it can be deduced that there are two important points of influence, which are directly related to the question and the person:

- The *specificity* of the risk question
- The tendency to *Fear* of a person

The result is likewise influenced by the educational level of the parents with regard to the theoretical study ability**.** This applies explicitly to that of the father and that of the mother (exception here: *Trust*). In addition, *Gender* and *Age* also have an influence on the propensity to indicate "0" risk. As already addressed by Dohmen et al. (2011). This leads to the following three factors that were also found to have an influence here:

- *Age*
- *Gender*
- Parents' individual level of education ("*Abitur: Father*", "*Abitur: Mother*")

All in all, this suspects to us, considering the above-mentioned evaluations, that risk is not always considered according to constant rational aspects, but is addressed situation-specifically based on the before mentioned individual and question immanent factors. Dohmen et al. (2015) underline this suspicion by emphasizing the influence of individual factors, as well as the advantage of a context specific question for the use of other perspectives in relation to risk taking. The assumption that a more specific question leads to a different (in this case risk-

averse) behaviour is also shown in the experimental findings of Loftus and Palmer (1974), as well as Loftus (1975). It is shown there that a different wording leads to a different consideration of the situation.

All this indicates that the specificity of the risk question influences the result, see Moulton and Kosslyn (2009). This confirms our hypothesis that the specific domains themselves (C*ar Driving*, *Financial Matters*, *Sports and Leisure*, *Career*, *Health* and *Trust*) lead to a lower willingness to take risks when it comes to the issue of risk.

We deduce that in the *General* and the specific domains, risk questions work differently since answer option "0" was more frequently stated in the domain specific questions. As already Charness et al. (2013) found out that the results of a risk assessment are only valid within the respective measurement scenario.

With regard to the variable *Fear*, Wake et al. (2020) show with their meta-analysis that there is a significant influence of *Fear* on risk behaviour. However, there are also other findings that show that there are no significant differences in risk and decision making between groups of people with an anxiety disorder and unaffected people, or even that there is an opposite effect (Kugler et al., 2010; Zhang et al., 2017). However, the meta-analysis of Wake et al. (2020) shows that these results are relatively rare and do not match the general findings.

Fear has an impact on stated risk preferences here and leads to a lower risk propensity. We extend our findings here by the supposed idea that the specificity of the question could be a possible stimulus for *Fear*, based on the influence of wording, shown by Loftus and Palmer (1974).

For us, it is therefore essential to address this relationship between the general and domain-specific questions as well as the influencing factors like *Fear* when considering risk preferences, and thus to challenge them for possible resulting biases. It should be added that there is a difference between the psychological and economic concepts in explaining heterogeneity and that these concepts should be used in a complementary way according to Becker et al. (2012).

We cannot provide exhaustive explanations for this anomaly within the scope of this study and leave them for future research. However, we offer an exploratory approach on the existence of such anomalies and highlight the importance of taking a closer look on abstract concepts such as (stated) risk preferences.

4 Conclusions

In the first paper, I show that abstracting-rational process tools and approaches are not part of the standard repertoire, especially in the medical-pharmaceutical context, and are not comprehensively addressed in everyday operations. Game theory is a significant field of research, especially in economics. However, it appears that the practical application of it, at least in everyday medical practice, has very limited visibility in research and at least does not appear in the usual database of medical issues. This shows me that although many decision-making situations occur in everyday surgery, this is not a commonly used methodology to represent such situations in an abstracted and ideally rational way. This is especially interesting since the other two studies show how effects influence us in perception and abstracting-rationalizing approaches are not yet fundamentally considered as shown in this study.

Drug evaluations, especially for marketing authorizations and reimbursement decisions, are highly complex and subject to national specifics. It was therefore even more interesting for me to see that the emphasis here is on the data themselves and how they differ. Specifically, which drug ultimately has a benefit in a direct comparison or a favorable risk-benefit profile. The presentation of the data plays a subordinate role. In the second study, I show that the presentation of the data alone can have a significant influence on the evaluation and thus lead to a potentially biased result. Here, a tabular presentation seems to be the significantly better of the two forms of presentation when it comes to obtaining a generally positivizing result. This cannot be said conclusively about the percentage or naturally frequency representation, since here the effects were still influenced from my view by whether it concerns a comparison superior in all ranges or a weighted comparison. In my view, the effect labelled by Gigerenzer (2007) as "statistical illiteracy" plays an important role here. It should be mentioned here that a graphical representation was not used as a comparator.

The third study focused on how we perceive risk and how we express it as a preference. It was found that the more specific the question, the higher the tendency to indicate "0", and that *Fear* also has a significant influence on how we indicate risks. This is an interesting finding in that this effect of specificity in relation to stated risk preferences has only been made visible to a very limited extent so far.

For me, therefore, the combination of the second and third studies derives the assumption that study two did not necessarily rationally capture the benefit-risk profile (where benefit here is emblematically the opposite of risk - positive/negative effect of the drug). Since here a specific risk scenario, with partially worse graspable data (percentage) was queried. This shows me that the effects found here can have a significant influence on these evaluations in everyday life.

In summary, it certainly makes sense to create awareness for the effects found here and to address the possible influences. However, since these are effects that fundamentally affect every person, it is thus virtually a systematic error. The advantage is that, in theory, this can usually be corrected or compensated for by intervention. From my point of view, it therefore makes sense to ensure by standardization that the subjective deviations occur identically everywhere, so that the comparability is given again, at least regarding drugs. Therefore, the question arises for me whether we correct these aspects in the future or at least consider them in our final statement. I hope to have contributed to the topic and possible future discussions with this work.

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Appendix A

A.1 Table 12: Boolean search operator

The PubMed and LIVIVO databases were searched using the following Boolean operators, see Bramer et al. (2018).

Search String	Translated Search Query (PubMed)
((“game+theory”) OR gametheory OR (nash+equilibrium) OR (prisoner+dilemma) OR (non-cooperative+game) OR (cooperative+game) OR (backward induction)) AND ((healthcare) OR (health care) OR (health industry) OR (health management))	*(“game+theory”[All Fields] OR gametheory[All Fields] OR nash+equilibrium[All Fields] OR (“prisoner dilemma”[MeSH Terms] OR (“prisoner”[All Fields] AND “dilemma”[All Fields]) OR “prisoner dilemma”[All Fields]) OR non-cooperative+game[All Fields] OR cooperative+game[All Fields] OR (backward[All Fields] AND induction[All Fields])) AND ((“delivery of health care”[MeSH Terms] OR (“delivery”[All Fields] AND “health”[All Fields] AND “care”[All Fields]) OR “delivery of health care”[All Fields] OR “healthcare”[All Fields]) OR (“delivery of health care”[MeSH Terms] OR (“delivery”[All Fields] AND “health”[All Fields] AND “care”[All Fields]) OR “delivery of health care”[All Fields] OR (“health”[All Fields] AND “care”[All Fields]) OR “health care”[All Fields]) OR ((“health”[MeSH Terms] OR “health”[All Fields]) AND (“industry”[MeSH Terms] OR “industry”[All Fields])) OR (“Health Manage”[Journal] OR (“health”[All Fields] AND “management”[All Fields]) OR “health management”[All Fields])) AND ((“2004/01/01”[PDAT] : “2019/03/31”[PDAT]) AND English[lang])*
(((((Negotiation) OR Bargaining))) AND Strategy) AND Health+Care	*((((“negotiating”[MeSH Terms] OR “negotiating”[All Fields] OR “negotiation”[All Fields]) OR Bargaining[All Fields]) AND Strategy[All Fields]) AND (“delivery of health care”[MeSH Terms] OR (“delivery”[All Fields] AND “health”[All Fields] AND “care”[All Fields]) OR “delivery of health care”[All Fields] OR (“health”[All Fields] AND “care”[All Fields]) OR “health care”[All Fields]) AND ((“2004/01/01”[PDAT] : “2019/03/31”[PDAT]) AND English[lang])*
(((Negotiation) OR Bargaining) AND ((game+theory) OR (nash+equilibrium))) AND Health+Care	*((((“negotiating”[MeSH Terms] OR “negotiating”[All Fields] OR “negotiation”[All Fields]) OR Bargaining[All Fields]) AND ((“game theory”[MeSH Terms] OR (“game”[All Fields] AND “theory”[All Fields]) OR “game theory”[All Fields]) OR nash+equilibrium[All Fields])) AND (“delivery of health care”[MeSH Terms] OR (“delivery”[All Fields] AND “health”[All Fields] AND “care”[All Fields]) OR “delivery of health care”[All Fields] OR (“health”[All Fields] AND “care”[All Fields]) OR “health care”[All*

	Fields]) AND (("2004/01/01"[PDAT] : "2019/03/31"[PDAT]) AND English[lang])
(((Price+negotiation) OR Pricing OR (Price+Bargaining) OR (Price+Strategy)) AND ((game+theory) OR (nash+equilibrium))) AND Health+Care	*((Price+negotiation[All Fields] OR ("costs and cost analysis"[MeSH Terms] OR ("costs"[All Fields] AND "cost"[All Fields] AND "analysis"[All Fields]) OR "costs and cost analysis"[All Fields] OR "pricing"[All Fields]) OR Price+Bargaining[All Fields] OR Price+Strategy[All Fields]) AND (("game theory"[MeSH Terms] OR ("game"[All Fields] AND "theory"[All Fields]) OR "game theory"[All Fields]) OR nash+equilibrium[All Fields])) AND ("delivery of health care"[MeSH Terms] OR ("delivery"[All Fields] AND "health"[All Fields] AND "care"[All Fields]) OR "delivery of health care"[All Fields] OR ("health"[All Fields] AND "care"[All Fields]) OR "health care"[All Fields]) AND (("2004/01/01"[PDAT] : "2019/03/31"[PDAT]) AND English[lang])*

Table 12: Boolean search operators for the literature search of the overview

A.2 Distribution of indexed literature

As indicated above the 126 cases in which game theory was used in the concept can be divided into the following categories: *Administration; Caregiver; Disease Management; E-Health; Hospital; Patients; Healthcare Professionals; Resource Allocation; Vaccination* and *Other.*

Below the articles are sorted within these categories. In the following a short summary indicating single examples of these categories is given:

Administration

10 articles out of 126 dealt with *Administration* scenarios. One example is the work of Creasy & Kinard (2013) where the authors analysed the representation of mergers and acquisitions as simple prisoner dilemmas. The emerging problems at the level of work culture are represented here by basic models of game theory.

Caregiver

9 articles out of 126 dealt with *Caregiver* scenarios. An example is the work of Sonnenberg (2017) where the author studied the inflated usage of endoscopic screenings and the underlying decision-making structures and came to the conclusion that general physicians should be educated about the general working procedures of endoscopy units and the alarm symptoms of digestive diseases.

Disease Management

5 articles out of 126 dealt with *Disease Management* scenarios. One example is the work of Athreya et al. (2017) where the authors proposed a two-player model

for risk prediction in adenocarcinoma and concluded that this model can predict the imminent onset.

E-Health

5 articles out of 126 dealt with *E-Health* scenarios. An example is the work of Kuljeet et al. (2015) where the authors proposed a technical model for the usage of internet of vehicles to provide healthcare on the fly, here the vehicles act as players. In conclusion the model proved to be effective in its environment.

Hospital

7 articles out of 126 dealt with *Hospital* scenarios. One example is the work of Knight et al. (2017) where the authors analysed the throughput and its optimization in hospitals by modelling the critical care unit interaction between hospitals in a game theoretic framework. It is shown that, if the capacity is not sufficient, rational behaviour can lead to a damaging effect on patient throughput.

Patients

7 articles out of 126 dealt with *Patient* scenarios. One example is the work of De Jaegher (2012) where the author describes a conflict of interests between physician and patient, about the treatment preferences and needs. As a result, the pay-off of the information status of the patient in comparison to the treatment is received.

Healthcare Professionals

4 articles out of 126 dealt with *Healthcare Professional* scenarios. An example is the work of Pikkel et al. (2016), where the authors studied the risk-taking behaviours of doctors with the goal of a deeper insight in the decision making processes of doctors.

Resource Allocation

20 articles out of 126 dealt with *Resource Allocation* scenarios. One example is the work of Nguyen & Rohlf (2012) where the authors analysed the German healthcare landscape and concluded that an installation of a citizen insurance leads to a decrease in drug quality.

Vaccination

13 articles out of 126 dealt with *Vaccination* scenarios. One example is the work of Shim et al. (2012) where the interests of the public are weighed against the interests of the individual, with the discrepancy increasing as the cost of vaccination increases.

Other

46 articles out of 126 did not fit in the categories shown beforehand. Due to the heterogeneity of topics addressed, a typical example is not present for this group.

A.3 Categorized literature

A.3.1 Administration

Table 13: Appendix: List of findings for Administration

Title	Authors	Publication Date	Short Summary
Sustainable network advantages: a game theoretic approach to community-based health care coalitions	Ford, Wells, Bailey	2004	The network was analysed using game theoretic approaches. Resulting in possible implications for improving
Competition among differentiated health plans under adverse selection	Olivella, Hernández	2007	Addressing local and global deviations from cross-subsidization with an equilibrium framework
Big pharma and health care: unsolvable conflict of interests between private enterprise and public health	Brezis	2008	Use of game theoretic approaches to show the bad influence of big pharmaceutical companies to public goods
Turf battles: game theory to social alliance	Cho	2008	Game theory as a tool to tackle potential turf battles in the area of health care
Health governance utopia	Bognar	2011	Giving an insight about game theory as a tool in the perspective of health economics
Shared Health Governance	Ruger	2011	Further development of the framework with

			game theoretic ideas
Health care mergers and acquisitions: implications of robbers cave realistic conflict theory and prisoner's dilemma game theory	Creasy, Kinard	2013	The representation of mergers and acquisitions as simple prisoner dilemmas. The emerging problems at the level of work culture are represented here by basic models of game theory. However, game theory only serves as an abstract model for simplification
Pricing, inventory and production policies in a supply chain of pharmacological products with rework process: a game theoretic approach	Taleizadeh, Noori-Daryan	2015	Optimization of profit with the use of a Stackelberg game model
Effects of asymmetric medical insurance subsidy on hospitals competition under non-price regulation	Wang, Nie	2016	Subsidy is both, helpful and harming. Stimulating the demand and also increasing prices
Analysis of current situation and influencing factor of medical disputes among different levels of medical institutions based on the game theory in Xiamen of China: A cross-sectional survey	Zeng , Zhang, Yao, Fang	2018	The main factors of medical disputes were identified and analyzed with the usage of game theoretic approaches

A.3.2 Caregiver

Table 14: Appendix: List of findings for Caregiver

Title	Authors	Publication Date	Short Summary
Models of the medical consultation: opportunities and limitations of a game theory perspective	Tarrant, Stokes, Colman	2004	Insights into underlying dynamics with patient-doctor interaction with

			three game theory models
Personal view: passing the buck and taking a free ride -- a game-theoretical approach to evasive management strategies in gastroenterology	Sonnenberg	2005	Patient management could be more efficient if doctors felt less threatened by administrative repercussions
The mystery of altruism and transcultural nursing	Dowd, Davidhizar, Giger	2007	Examination of different factors for the profession individuals choose
Continuity and Trust in Primary Care: A Qualitative Study Informed by Game Theory	Tarrant, Dixon-Woods, Colman, Stokes	2010	The relationship of trust and continuity care and the importance of it
Oncologist preferences for health states associated with the treatment of advanced ovarian cancer	Hess, Malone, Skrepnek, Reed, Armstrong, Coons	2010	It is concluded that more severe adverse reactions are only accepted in cases of large improvement
To Report or Not to Report: Applying Game Theory to Nursing Error Reporting	Barrachina, Gonzalez-Chorda	2016	A theoretic model for manager – nurse interaction on the rationale of reporting errors
Cry wolf and inflate medical urgency to expedite consult resolution through gastrointestinal endoscopy	Sonnenberg	2017	An education program was found as a result of communications problems, identified by game theoretic approaches
Understanding the process of clinical judgement for pharmacists when making clinical decisions	Duffull, Anakin, Wright	2018	Game theory was used to explore clinical decision making and the respective components
Optimizing Cancer Treatment Using Game Theory: A Review.	Staňková, Brown, Dalton, Gatenby	2019	A game theoretic contest between therapy and resistance strategies of cancer, where physicians can exploit advantages

			in more dynamic treatment protocols

A.3.3 Disease Management

Table 15: Appendix: List of findings for Disease Management

Title	Authors	Publication Date	Short Summary
Mathematical modeling of the course and prognosis of factitious disorders: a game-theoretic approach	Rashidi, Khodarahmi, Feldman	2006	Explanation of possible unknown mechanics and underlying variables
The Case for Cooperation in Managing and Maintaining the End of Poliomyelitis: Stockpile Needs and Coordinated OPV Cessation	Thompson, Tebbens	2008	Game theoretical approach for the importance of global cooperation in disease eradication
Incentive compatibility in kidney exchange problems	Villa, Patrone	2009	It is shown that the mechanism is subject to possible manipulation by the player to profit from their misrepresentation of information
Complex intervention modelling should capture the dynamics of adaptation	Greenwood-Lee, Hawe, Nettel-Aguirre, Shiell, Marshall	2016	The inclusion of game theoretic approaches into guidelines for complex interventions is discussed
Prediction of adenocarcinoma development using game theory	Athreya, Armstrong, Gundling, Wildman, Kalbarczyk, Iyer	2017	Changes in gene expression are used to predict the risk of ardenocarcinoma

A.3.4 E-Health

Table 16: Appendix: List of findings for E-Health

Title	Authors	Publication Date	Short Summary
Interference Mitigation for Cyber-Physical Wireless Body Area Network System Using Social Networks	Zhang, Wang, Wang, Fang	2013	A game theoretic approach for the usage of wireless body are networks in a dense hospital environment
Providing healthcare services on-the-fly using multi-player cooperation game theory in Internet of Vehicles (IoV) environment	Kumar, Kaur, Jindal, Rodrigues	2015	Technical game theory approach for on-the-fly healthcare
Game Theory Based Security in Wireless Body Area Network with Stackelberg Security Equilibrium	Somasundaram, Sivakumar	2015	A proposed security concept for health care diagnostics
An Open Source Tool for Game Theoretic Health Data De-Identification	Prasser, Gaupp, Wan, Xia, Vorobeychik, Kantarcioglu, Kuhn, Malin,	2017	Discussion of a new game theory-based data publication strategy
An Evolutionary Game-Theoretic Approach for Assessing Privacy Protection in mHealth Systems	Zhu, Liu, Feng	2018	Quantified approach for optimal strategy of private investment and regulation

A.3.5 Hospital

Table 17: Appendix: List of findings for Hospital

Title	Authors	Publication Date	Short Summary
Applied game theory for the hospital manager. Three case studies	Dowd	2004	Introduction into terminology and three simplified examples how it could be used for modeling strategy
Hospital Healthcare-Service Satisfaction Risk Assessment and GameTheoretic Risk Management using an	Sahinoglu, Samelo, Wool, Morton	2013	Dealing with implementing a methodology about how to improve patient centered quality of care

Algorithmic RoM (Risk-O-Meter) *Software for a Quantitative Case Study in Alabama-USA*			utilizing cost-effectiveness
Applying principles from the game theory to acute stroke care: Learning from the prisoner's dilemma, stag-hunt, and other strategies	Saposnik, Johnston	2016	The decisions under uncertainty in stroke care can be improved by using game theoretic approaches
Strategy on doctor resource sharing among hospitals composed regional medical association based on Game Theory	Zongwei, Chuanqing, Haini	2017	Analysis of resource sharing factors and the resulting strategies
Measuring the price of anarchy in critical care unit interactions	Knight, Komenda, Griffiths	2017	The throughput and its optimization in hospitals, by modelling the critical care unit interaction between hospitals in a game theoretic framework were analyzed
John Nash and the Organization of Stroke Care	Goyal, Wilson, Mayank, Kamal, Robinson, Turkel-Parrella, Hirsch	2018	Application of equilibrium idea to the treatment of acute ischemic stroke on a multi hospital level
Incentivizing hospital infection control	Drohan, Levin, Grenfell, Laxminarayan	2019	Game theoretic approach on spending behaviour to tackle hospital-associated infections

A.3.6 Patients

Table 18: Appendix: List of findings for Patients

Title	Authors	Publication Date	Short Summary
Defecting or not defecting: how to "read" human behavior during cooperative games by EEG measurements	Fallani, Nicosia, Sinatra, Astolfi, Cincotti, Mattia, Wilke, Doud, Latora, He, Babiloni	2010	Linking brain networks to the results of a prisoners dilemma game and showing that there is the possibility to see their decision beforehand
The value of private patient information in the physician-patient relationship: a game-theoretic account	De Jaegher	2012	The influence of patient information on the treatment outcome was described
When is it rational to participate in a clinical trial? A game theory approach incorporating trust, regret and guilt	Djulbegovic, Hozo	2012	A trust version of the prisoners dilemma was used to show rationales for participation
A non-cooperative game with incomplete information to improve patient hospital choice	Song, Wen	2015	Game theoretic approach to static and dynamic factors on patients' hospital choice
The application of Signaling Theory to health-related trust problems: The example of herbal clinics in Ghana and Tanzania.	Hampshire, Hamill, Mariwah, Mwanga, Amoako-Sakyi	2017	Health related trust problems under uncertainty in "herbal clinics" in Ghana and Tanzania were investigated for a proof of usage of signaling theory models in such cases
End-of-life chemotherapy: a prisoner's dilemma?	Yeung, Hebert	2018	Identifying driving factors for end-of-life chemotherapy
Use of Game Theory to model patient engagement after surgery: a qualitative analysis	Castellanos, Buentello, Gutierrez-Meza, Forgues, Haubert, Artinyan, Macdonald, Suliburk	2018	It shows that increased doctor - patient interaction can lead a better patient engagement. Thus, using game theory

			to model tailored strategies and responses

A.3.7 Healthcare Professionals

Table 19: Appendix: List of findings for Healthcare Professionals

Title	Authors	Publication Date	Short Summary
Decision making for health care managers and supervisors: theory into practice	Layman	2011	Comparison of common decision theories
Mentoring and dental foundation training	Mauthe	2012	Application of game theory ideas for training concepts
Modern health care as a game theory problem	Djulbegovic, Hozo, Ioannidis	2015	Describing the usage of game theoretic approaches for patient-physicians' models to tackle the increase in expenditure
Are doctors risk takers?	Pikkel, Pikkel Igal, Sharabi-Nov, Pikkel	2016	Understanding risk taking tendencies for better insight in their decision making process

A.3.8 Resource Allocation

Table 20: Appendix: List of findings for Resource Allocation

Title	Authors	Publication Date	Short Summary
A short review of game theory for neurosurgeons	Steiger, Steiger	2011	A game theoretic approach of competing for limited resources
Private Health Care and Drug Quality in Germany – A Game-Theoretical Approach	Nguyen, Rohlf	2012	A game theoretic approach that shows a decrease in drug quality if citizen insurance is installed in Germany

Lessons from game theory about healthcare system price inflation: evidence from a community-level case study	Agee, Gates	2013	In a study about healthcare system price inflation, different pricing frameworks, autonomously priced fee-for-service and cooperative modified pricing and incentive strategies, in the field of medical devices were compared
Game Theory for Cost Allocation in Healthcare	Kolker	2013	Two main concepts for allocation of costs are presented: nucleolus and shapley value
Too small to fail: the prisoner's dilemma	Sumpio	2013	Strategic planning and resource allocation in the field of vascular surgery
Introducing competition in healthcare services: The role of private care and increased patient mobility	Andritsos, Tang	2014	Showing that the presence of a private provider and cross border healthcare policies are beneficial
Optimal Screening Strategies for Healthcare Associated Infections in a Multi-Institutional Setting	Miller, Polgreen, Polgreen	2014	Usage of game theoretic approaches for strategic screening decisions in case of diseases
Impact of a financial risk-sharing scheme on budget-impact estimations: a game-theoretic approach	Gavious, Greenberg, Hammerman, Segev	2014	Usage of game theoretic models to find potential equilibria in budget estimates
Multiple Interacting Risk Factors: On Methods for Allocating Risk Factor Interactions	Price, MacNicoll	2015	Comparing a weighing method versus a game theoretic approach for allocating risk factor interactions.

Organ transplantation: an introduction to game theory	Skaro , Hazen, Kaplan	2015	Development of the extensive form of a sequential game whether high or low risk organs should be transplanted
Access to critical medicines: when are compulsory licenses effective in price negotiations?	SV Ramani, E. Urias	2015	Ramani and Urias investigated the influence of compulsory licenses on drug negotiations and is only a short-term solution
Provider Behavior Under Global Budgeting and Policy Responses: An Observational Study on Eye Care Services in Taiwan	Chang, Xirasagar, Chen, Hussey, Wang, Chen, Lian	2015	It shows that monitored global budgeting and timely responses can contain costs
Aligning provider incentives to improve primary healthcare delivery in the United States	DeVoe, Stenger	2016	A "prisoners dilemma"model was used to show that a combination of guaranteed payment and incentives encourage providers to do deliver higher quality care
Optimizing annotation resources for natural language de-identification via a game theoretic framework	Li, Carrell, Aberdeen, Hirschman, Kirby, Li, Vorobeychik, Malin	2016	A game theoretic approach enables a refined cost-benefit tradeoff, improving both privacy and utility for the health care organisation
A New Model for Supply Chain Quality Management of Hospital Medical Equipment through Game Theory	Malmir, Dehghani, Jahantigh, Najjartabar	2016	Strategies of supplying companies were modelled with a game theoretic approach
Collaborative Operating Room Planning and Scheduling	Roshanaei, Luong, Aleman, Urbach	2017	Analysis of resource allocation and optimal distribution on a

			multi hospital network
Caesarean Section vs. Normal Vaginal Delivery: A Game Theory Discussion in Reimbursement Interventions	Mohammadshahi, Hematyar, Najafi, Sakha, Pourreza	2018	As a result, taxes and fines are a solution for a high rate of c-section in Iran
A Game-Theoretic Approach to Share the Costs of Cooperating Healthcare Networks	Lightfoot	2019	A modeled approach that shows an increase of costs in case of dropping unnecessary competition
A hybrid data envelopment analysis and game theory model for performance measurement in healthcare	Zare, Tavana, Mardani, Masoudian, Saraji	2019	Usage of game theoretic models to gain insights of the measurement of performance and productivity

A.3.9 Vaccination

Table 21: Appendix: List of findings for Vaccination

Title	Authors	Publication Date	Short Summary
Imitation dynamics predict vaccinating behavior	Bauch	2005	Due to herd immunity, a strategic interaction between individuals also arises from the nature of their decision
Dynamics of vaccination strategies via projected dynamical systems	Cojocaru, Bauch, Johnston	2007	Analysis of individual attempts to maximize their health in relation to the dependance of this status from others
Optimal vaccination choice, vaccination games, and rational exemption: an appraisal	Manfredi, Della Posta, d'Onofrio, Salinelli, Centrone, Meo, Poletti	2009	Description of implications of rational exemption by vaccination choice models

Smallpox, risks of terrorist attacks, and the Nash equilibrium: an introduction to game theory and an examination of the smallpox vaccination program	Hamilton, McCain	2009	A possible benefit in emergency preparedness by using a game theory concept for analysing specific terrorism/ counter terrorism strategies
Imitation dynamics of vaccination behavior on social networks	Fu, Rosenbloom, Wang, Nowak	2010	Description of individual vaccination choices in social networks, driven by game theoretic framework
A game dynamic model for delayer strategies in vaccinating behaviour for pediatric infectious diseases	Bhattacharyya, Bauch	2010	Insight in possible delaying strategies and various dynamics in the case of vaccinations
"Wait and see" vaccinating behaviour during a pandemic: a game theoretic analysis	Bhattacharyya, Bauch	2011	Analysis of two sources of strategic interaction: Vaccination cost and probability of infection
Health newscasts for increasing influenza vaccination coverage: an inductive reasoning game approach	Breban	2011	Behaviour and the underlying factors of individuals in case of an influenza vaccination
A game dynamic model for vaccine skeptics and vaccine believers: measles as an example	Shim, Grefenstette, Albert, Cakouros, Burke	2012	The interests of the public are weighed against the interests of the individual, with the discrepancy increasing as the cost of vaccination increases
Outcome Inelasticity and Outcome Variability in Behaviour-Incidence Models: An Example from an SEIR Infection on a Dynamic Network	Morsky, Bauch	2012	Different vaccination models and strategies with their respective consequences were presented
Vaccination, herd behavior, and herd immunity	Cohen, Brezis, Block, Diederich, Chinitz	2013	Identifying dominant strategies regarding the

			vaccination situation
The Measles and Free Riders	Browne	2016	A game theoretic perspective on a Californian bill, which closes all exemption in school-mandated vaccinations
Quantifying and explaining accessibility with application to the 2009 H1N1 vaccination campaign	Heier Stamm, Serban, Swann, Wortley	2017	Developing a general methodology to measure potential spatial accessibility

A.3.10 Other

Table 22: Appendix: List of findings for Other

Title	Authors	Publication Date	Short Summary
Personal view: 'don't ask, don't tell'--the undesirable consequences of incidental test results in gastroenterology	Sonnenberg	2004	General management strategy development for endoscopic procedures after incidental test results
Medical ethics, logic traps, and game theory: an illustrative tale of brain death	Riggs	2004	A situation of possible brain death is discussed from a prisoners dilemma perspective
The drug bargaining game: pharmaceutical regulation in Australia	Wright	2004	Wright presents the Australian pharmaceutical market, which regulates the price consumers pay, as a multi-stage game between regulators and pharmaceutical companies
The consultation game	Elwyn	2004	Addressing quality with game theory
Personal view: victim blaming as management	Sonnenberg	2005	On the long run shifting blame is no

strategy for the gastroenterologist--a game theoretical approach			suitable strategy and becomes unproductive for both participants
Prisoners' dilemma: the importance of negative results	Probst	2006	Prisoners dilemma as a metaphor for unpublished results and thus not cooperative behaviour
Personal view: the paradox of runaway competitions in gastroenterology	Sonnenberg	2006	A prisoners dilemma model was used to analyse competitions and identify avoiding strategies
The decision to conduct a head-to-head comparative trial: a game-theoretic analysis	Mansley, Elbasha, Teutsch, Berger	2007	Game theoretic approach to the willingness and decision of a pharmaceutical company to conduct such trials
Medicines concordance and game theory	Hughes	2008	A commentary on Aslani P de Almeida Neto A [2008] "Medicines concordance in clinical practice "
Costly punishment does not always increase cooperation	Wu, Zhang, Zhou, He, Zheng, Cressman, Tao	2009	Repeated two players prisoners dilemma show a cultural difference between Beijing and Boston
Competition and quality in health care markets: A differential-game approach	Brekke, Cellini, Siciliani, Straume	2010	Exaggeration of positive effect on the quality competition in static models
Playing 'games' with human health the role of game theory in optimizing reliability in wireless health networks	Gupta, Cianca, Patel, Kaligotla, Gogar, Wardana, Lam, Ganguly	2010	Co-operative games used as a foundation for distribution mechanisms on a technical level
Primary care delivery, risk pooling and economic efficiency	Leung	2010	A game theoretic approach which describes potential

			usage of regulation beneficial
A game-theoretic framework for estimating a health purchaser's willingness-to-pay for health and for expansion	Yaesoubi, Roberts	2010	Proposing the framework and underlying mechanisms for expansion, as well as an application to real world data
Unified performance evaluation of health centers with integrated model of data envelopment analysis and bargaining game	Rezaee, Moini, Asgari	2012	Combination of bargaining game model with data envelopment analysis for a single measurement method
Succeeding in research: insights from management and game theory	Clark, Thompson	2013	Game theoretical insights on research and publication strategies in nurse academia
Multi-stakeholder decision analysis and comparative risk assessment for reuse-recycle oriented e-waste management strategies: a game theoretic approach	Kaushal, Nema	2013	A complex model to analyse strategies for hazardous waste treatment and potential health risk for the public
Priority-based time-slot allocation in wireless body area networks during medical emergency situations: an evolutionary game-theoretic perspective.	Misra, Sarkar	2014	An evolutionary game model is considered, allowing a local data processing unit to use active and passive strategies while transmitting data
Bargaining and informal interactions in the national budget: a game theory analysis of the Israeli case	Cohen	2014	Analysis of politician and bureaucrat interaction with game theoretical tools
Bargaining Ability and Competitive Advantage: Empirical Evidence from Medical Devices	Grennan	2014	It shows that bargaining ability is an important source of a company's profitability

Economics of epilepsy surgery	Sadanand	2014	A game theoretic approach with imperfect information is used for surgical decision-making
N-player mosquito net game: individual and social rationality in the misuse of insecticide-treated nets	Honjo, Satake	2014	Showing a nash-equilibrium for the usage of insecticide-treated nets and the resulting benefits and costs
Commentary on: Clark A. M. & Thompson D. R. (2013) Succeeding in research: insights from management and game theory. Journal of Advanced Nursing 69(6), 1221-1223	Kelly	2014	Commentary on: Clark A. M. & Thompson D. R. (2013) Succeeding in research: insights from management and game theory. Journal of Advanced Nursing 69(6), 1221-1223
Environmental Resource Management in Borderlands: Evolution from Competing Interests to Common Aversions	Buckley, Belec, Levy	2015	Game theoretic approach to cross-border region resource management
A game-theoretic approach to valuating toxoplasmosis vaccination strategies	Sykes, Rychtář	2015	A predictive model about the vaccination strategies and values of cat owners
Model for the spread of SIS epidemic based on evolution game	Yang, Yang	2015	Analysis of detailed information of evolution and game relationship between individuals
Rebuilding trust – the real challenge for health system improvement	Sturmberg	2015	Giving more insights to the reasoning of Djulbegovic [2015] "Modern health care as a game theory problem"
A Multi-User Game-Theoretical Multipath Routing Protocol to Send	Mezher, Igartua, De la Cruz, Segarra, Tripp-Barba, Urquiza-	2015	An approach for individual strategic demand concepts

Video-Warning Messages over Mobile Ad Hoc Networks	Aguiar, Forné , Gargallo		of emergency situations
Dopamine Modulates Egalitarian Behavior In Humans	Sáez, Zhu, Set, Kayser, Hsu	2015	Game theoretic models were used to show a link between neurochemical systems and prosocial behaviour
SIS evolutionary game model and multi-agent simulation of an infectious disease emergency	Yang, Yang, Liu, Wang	2015	A discussion of strategic models between the public and states in case of an infectious disease
Physician-patient relationship and medical accident victim compensation: some insights into the French regulatory system	Oros, Ancelot	2015	Comparison of two compensation systems with insights from game theory
A house divided: cooperative and competitive recruitment in vital industries	Willis, Muslin, Timko	2016	Usage of cooperative strategies in a labour market shortage leads to realistic job previews
What Can We Expect from Value-Based Funding of Medicines? A Retrospective Study	Harris, Li, Yong	2016	Harris shows that retrospectively the value-based funding of drugs in Australia corresponds to the game theoretical models used for this purpose. Overall, as the strength of bargaining power increases, the likelihood of funding increases
Game theory and strategy in medical training	Blake, Carroll	2016	Game theory as a tool can identify competing priorities
Sustainability of Healthcare Information	Demirezen, Kumar, Sen	2016	Modeled approach to healthcare

Exchanges: A Game-Theoretic Approach			information exchange and the analysis of sustainability and participation levels
Overcoming resistance against managed care - insights from a bargaining model	Ehlert, Wein, Zweifel	2017	A choice between two payment settings for the consumer. Social health insurer or managed care organisations
Economics of Palliative and End-of-Life Care in India: A Concept Paper	Ghoshal, Damani, Salins, Deodhar, Muckaden	2017	Usage of game theory to show the underlying mechanisms and complexities of the Indian system
Balancing nanotoxicity and returns in health applications: The Prisoner's Dilemma	Gkika, Magafas	2017	Prisoners' dilemma for approaching the conflict between toxicity as cost and potential scientific benefit
Modeling the Social Dynamics of Moral Enhancement: Social Strategies Sold Over the Counter and the Stability of Society	Fabiano, Sandberg	2017	A simulated game that shows that individually maximized payoff can lead to shifts in society that reduces the overall satisfaction
A strategic gaming model for health information exchange markets	Martinez, Feijoo, Zayas-Castro, Levin, Das	2018	Health information exchange adoption decisions are analysed with a strategic game theoretic model und market conditions
Modeling and designing health care payment innovations for medical imaging	Zhang, Wernz, Hughes	2018	Game theoretic approach for effective payment systems
Regional regulators in health care service under quality competition: A game theoretical model	Bisceglia, Cellini, Grilli	2018	Game theoretic approach for regional price regulations and the

			interdependence of the regulators
Evolution Model of Health Food Safety Risk Based on Prospect Theory	Luo, Ma, Zhao, Chen	2018	A three party game with theoretic concepts regarding the evolution of the food safety risk
The role of Prefrontal Cortex in a Battle of the Sexes Dilemma involving a Conflict between Tribal and Romantic love	Duarte, Brito-Costa, Cayolla , Castelo-Branco	2018	Identifying of a critical segregation of the prefrontal regions in affective decision making
Evolutionary Game Theory Can Explain the Choice Between Apoptotic and Necrotic Pathways in Neutrophils	Presbitero, Mancini, Castiglione, Krzhizhanovskaya, Quax	2018	Understanding of tradeoff between cost and benefit of neutrophil death pathways
The Interaction between Insurance Organizations and Health System: The Insurance Mechanism based on Game Theory	Pakdaman, Shafiei, Hejazi, Abdi	2019	Identifying interactive behaviour for designing a game theory-based insurance mechanism

Appendix B

B.1 General presentation of the early benefit assessment according to AMNOG

This national procedure is regulated in Germany in the AMNOG (German Drug Market Restructuring Act), § 35a of the SGB V. It assesses whether the drug submitted by the pharmaceutical manufacturer has an added benefit compared to the appropriate comparator therapy. The GBA review procedure in Germany is initialized by a dossier submission to the GBA. The GBA commissions an institute to provide a scientific report, which assesses the drug's clinical data in an early benefit assessment. This scientific institute is usually the IQWiG. After three months, IQWiG then makes a recommendation on the added benefit of the drug concerned. This is followed by a hearing procedure of pharmaceutical companies and other involved parties. Finally, after six months, GBA decides whether an added benefit is present. If none is present, the reimbursement is usually based on fixed amounts, for drugs that can be sorted into the reference price groups. Otherwise, price negotiations will also take place, whereby the price should not exceed that of the appropriate comparative therapy. If an added benefit is present, the price is negotiated with the statutory health insurance association. The decision is given in the twelfth month. This is a black box procedure. If an agreement is reached, the discounted price applies after one year of free pricing. In the event of disagreement, the matter is passed on to an arbitration board, and the agreement is settled after 15 months, as previously mentioned. See Figure 8.

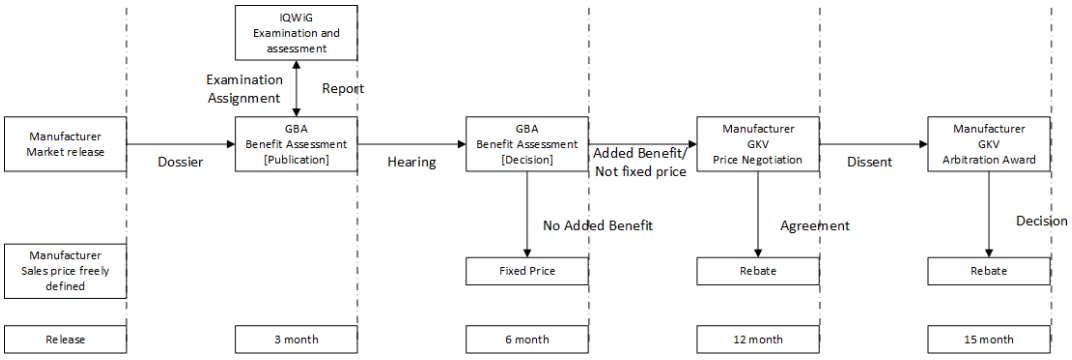


Figure 6: AMNOG procedure (IQWiG 2020b).

B.2 Example questionnaire as issued

Figure 7: Example questionnaire – data presentation on drug assessment

Fragebogen im Rahmen einer Promotion

Diese Befragung ist ein Teil eines wissenschaftlichen Projekts. Die im Folgenden erhobenen Daten dienen ausschließlich Forschungszwecken. Ihre Angaben werden anonym und vertraulich behandelt.

Persönliche Daten

Alter:		Geschlecht:	□ weiblich□ männlich□ divers

Familienstand:
- □ ledig
- □ verheiratet
- □ verwitwet
- □ geschieden
- □ Sonstiges: _____

Bitte geben sie ihre Studienrichtung an:
Wählen sie die bitte für sie passende Kategorie/ Bitte bei Lehramt ein 2. Kreuz, wenn dieses studiert wird

□ Naturwissenschaften	□ Medizin/ Pharmazie/ Life Sciences
□ Wirtschaftswissenschaften	□ Formalwissenschaft
□ Jura	□ Technische Studiengänge
□ Sozialwissenschaften	□ Sonstiges: _____
□ Geisteswissenschaften	□ Lehramt

Welchen Abschluss streben sie aktuell an? Bitte geben sie noch die Art der Hochschule an.

□ Bachelor	□ Promotion
□ Master	□ Universität
□ Diplom	□ HAW
□ Magister	□ Kunsthochschule

Welche Krankenversicherung bzw. -versorgung haben Sie?

□ Gesetzliche Krankenversicherung (GKV)	□ Sonstiges: _____
□ Private Krankenversicherung	

Wieviel Geld steht ihnen monatlich nach Abzug ihrer Mietkosten zur Verfügung?
- □ weniger als 100 €
- □ 100 € bis 200 €
- □ 201 € bis 300 €
- □ 301 € bis 400 €
- □ 401 € bis 500 €
- □ 501 € bis 600 €
- □ 601 € bis 700 €
- □ mehr als 700 €

Falls Sie einen **gemeinsamen Haushalt** mit einer weiteren Person führen, geben Sie bitte an, wie hoch in etwa das **gemeinsame** Budget Ihres Haushalts ist:

ca. _____ €

Allgemeine Fragen

Wie schätzen Sie sich persönlich ein: Sind Sie im Allgemeinen ein risikobereiter Mensch oder versuchen Sie Risiken zu vermeiden?									
Gar nicht risikobereit									**Sehr risikobereit**
□	□	□	□	□	□	□	□	□	□
1	2	3	4	5	6	7	8	9	10

Wie zufrieden sind Sie **gegenwärtig** mit den folgenden Bereichen Ihres Lebens?	**Ganz und gar unzufrieden**					**Ganz und gar zufrieden**
- Mit ihrer Freizeit?	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Mit ihrem Familienleben?	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Mit ihrem Freundes-/ Bekanntenkreis?	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Mit ihrer Gesundheit?	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6

Alles in allem: Wie zufrieden sind Sie gegenwärtig mit Ihrem Leben?					
Ganz und gar unzufrieden					**Ganz und gar zufrieden**
1	2	3	4	5	6
□	□	□	□	□	□

Wie wichtig sind folgende Dinge für Sie?	**Gar nicht wichtig**					**Sehr wichtig**
- Sich etwas leisten können	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Für andere da sein	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Sich selbst verwirklichen	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Erfolg im Beruf haben	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Ein eigenes Haus haben	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Eine glückliche Ehe / Partnerschaft haben	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Kinder haben	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- Sich politisch, gesellschaftlich einsetzen	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6

Rauchen Sie?	
□ Ja, täglich	□ Nein, nicht mehr
□ Ja, gelegentlich	□ Ich habe noch nie geraucht

Wie oft trinken Sie in der Woche Alkohol?	
□ Täglich oder fast täglich	□ An 1 - 2 Tagen pro Woche
□ An 5 - 6 Tagen pro Woche	□ Nie
□ An 3 - 4 Tagen pro Woche	

Fragen zu politischen Themen

Wie wichtig ist Ihnen das soziale Sicherungssystem in Deutschland?					
Nicht wichtig					**Sehr wichtig**
1	2	3	4	5	6
□	□	□	□	□	□

Finden Sie das sozial Sicherungssystem in Deutschland sollte ausgebaut oder eher abgebaut werden?	
□ Ausgebaut	□ Abgebaut

Würden Sie sagen, dass Ihnen eher an Gleichheit in der Gesellschaft oder an persönlicher Freiheit gelegen ist?	
□ Gleichheit	□ Freiheit

Wie beurteilen Sie die Gerechtigkeit der Lebensumstände in Deutschland und weltweit?						
	Sehr unfair					**Sehr fair**
- Deutschland	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6
- weltweit	□ 1	□ 2	□ 3	□ 4	□ 5	□ 6

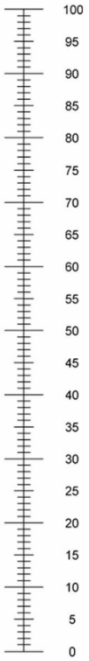
Wie schätzen Sie die medizinische Versorgung in Deutschland ein?					
Schlecht					**Sehr gut**
1	2	3	4	5	6
□	□	□	□	□	□

Gesundheitszustand (Bitte kreuzen Sie unter jeder Überschrift DAS Kästchen an, das Ihre Gesundheit HEUTE am besten beschreibt.)	
BEWEGLICHKEIT / MOBILITÄT	
Ich habe keine Probleme zu gehen	❑
Ich habe leichte Probleme zu gehen	❑
Ich habe mäßige Probleme zu gehen	❑
Ich habe große Probleme zu gehen	❑
Ich bin nicht in der Lage zu gehen	❑
FÜR SICH SELBST SORGEN	
Ich habe keine Probleme, mich selbst zu waschen oder anzuziehen	❑
Ich habe leichte Probleme, mich selbst zu waschen oder anzuziehen	❑
Ich habe mäßige Probleme, mich selbst zu waschen oder anzuziehen	❑
Ich habe große Probleme, mich selbst zu waschen oder anzuziehen	❑
Ich bin nicht in der Lage, mich selbst zu waschen oder anzuziehen	❑
ALLTÄGLICHE TÄTIGKEITEN *(z.B. Arbeit, Studium, Hausarbeit, Familien- oder Freizeitaktivitäten)*	
Ich habe keine Probleme, meinen alltäglichen Tätigkeiten nachzugehen	❑
Ich habe leichte Probleme, meinen alltäglichen Tätigkeiten nachzugehen	❑
Ich habe mäßige Probleme, meinen alltäglichen Tätigkeiten nachzugehen	❑
Ich habe große Probleme, meinen alltäglichen Tätigkeiten nachzugehen	❑
Ich bin nicht in der Lage, meinen alltäglichen Tätigkeiten nachzugehen	❑
SCHMERZEN / KÖRPERLICHE BESCHWERDEN	
Ich habe keine Schmerzen oder Beschwerden	❑
Ich habe leichte Schmerzen oder Beschwerden	❑
Ich habe mäßige Schmerzen oder Beschwerden	❑
Ich habe starke Schmerzen oder Beschwerden	❑
Ich habe extreme Schmerzen oder Beschwerden	❑
ANGST / NIEDERGESCHLAGENHEIT	
Ich bin nicht ängstlich oder deprimiert	❑
Ich bin ein wenig ängstlich oder deprimiert	❑
Ich bin mäßig ängstlich oder deprimiert	❑
Ich bin sehr ängstlich oder deprimiert	❑
Ich bin extrem ängstlich oder deprimiert	❑

- Wir wollen herausfinden, wie gut oder schlecht Ihre Gesundheit HEUTE ist.
- Diese Skala ist mit Zahlen von 0 bis 100 versehen.
- 100 ist die beste Gesundheit, die Sie sich vorstellen können.
- 0 (Null) ist die schlechteste Gesundheit, die Sie sich vorstellen können.
- Bitte kreuzen Sie den Punkt auf der Skala an, der Ihre Gesundheit HEUTE am besten beschreibt.
- Jetzt tragen Sie bitte die Zahl, die Sie auf der Skala angekreuzt haben, in das Kästchen unten ein.

IHRE GESUNDHEIT HEUTE = ☐

Beste Gesundheit, die Sie sich vorstellen können



Schlechteste Gesundheit, die Sie sich vorstellen können

Themen-bezogen

Ihre Einschätzung

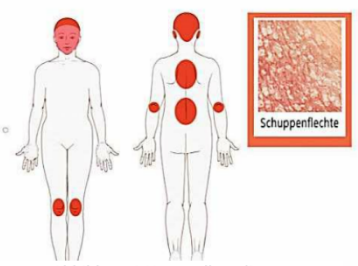


Abbildung 1 Hautstellen, die von Schuppenflechte betroffen sind. (© IQWiG)

Schuppenflechte: Hierbei handelt es sich um eine chronische Erkrankung. Diese zeigt sich durch eine Entzündung der Haut mit schmerzhaft rötlichen Flecken, die weiße Schuppen bilden. Besonders betroffen sind Ohren, Gesicht, Knie, Ellenbogen und Rücken. Durch den starken Juckreiz ist es schwer einzuschlafen und man ist tagsüber oft erschöpft und müde. Die Beschwerden kommen in Schüben.

Hierbei handelt es sich um einen Vergleich von 2 verfügbaren Arzneimitteln zu Therapie von Schuppenflechte.

	Altes Arzneimittel	Neues Arzneimittel
Rückgang der Schwere	23 %	63%
Rückgang des Juckreizes	38%	72%
Rückgang der Rötung	38%	72%
Rückgang der Schmerzen	54%	83%
Rückgang des Brennens	63%	85%
Steigerung Lebensqualität	53%	76%
Aufgetretene Nebenwirkungen	80%	71%

Medikamentengabe: Die Medikamente wurden im Abstand von 12 Wochen in einem Zeitraum von 52 Wochen unter die Haut gespritzt.

Bitte geben sie in den folgenden Fragen an, in wie weit sie einen Vorteil sehen. Wählen sie aus, wie stark sie die jeweilige Medikation für besser halten.

Die allgemeine Verträglichkeit des Medikaments							
Altes Medikament							**Neues Medikament**
□	□	□	□	□	□	□	□
4	3	2	1	1	2	3	4
Erheblich	Beträchtlich		Geringfügig		Beträchtlich		Erheblich

Die Zunahme der Lebensqualität							
Altes Medikament							**Neues Medikament**
□	□	□	□	□	□	□	□
4	3	2	1	1	2	3	4
Erheblich	Beträchtlich		Geringfügig		Beträchtlich		Erheblich

Reduktion der Schmerzen							
Altes Medikament							**Neues Medikament**
□	□	□	□	□	□	□	□
4	3	2	1	1	2	3	4
Erheblich	Beträchtlich		Geringfügig		Beträchtlich		Erheblich

Generelle Wirksamkeit des Arzneimittels							
Altes Medikament							**Neues Medikament**
□	□	□	□	□	□	□	□
4	3	2	1	1	2	3	4
Erheblich	Beträchtlich		Geringfügig		Beträchtlich		Erheblich

Ist eines der beiden Arzneimittel insgesamt besser ?							
Altes Medikament							**Neues Medikament**
□	□	□	□	□	□	□	□
4	3	2	1	1	2	3	4
Erheblich	Beträchtlich		Geringfügig		Beträchtlich		Erheblich

Sehen Sie einen Vorteil in der neuen Therapie?	
□ Ja	□ Nein

Falls ja, wie würden Sie das Ausmaß des Vorteils bewerten.									
Sehr geringer Vorteil									**Sehr großer Vorteil**
□	□	□	□	□	□	□	□	□	□
1	2	3	4	5	6	7	8	9	10

Würden sie als betroffene Person das neue Medikament nutzen?	
□ Ja	□ Nein

B.3 Exemplary explanatory presentation of the possible variants of all questionnaires

Questionnaire/ Scenario 1 [Plaque Psoriasis]:

Psoriasis: This is a chronic disease. It is characterised by an inflammation of the skin with painful reddish spots that form white scales. The ears, face, knees, elbows and back are particularly affected. The intense itching makes it difficult to fall asleep and one is often exhausted and tired during the day. The symptoms come in episodes.

Symptom	Old Drug	New Drug
Reduction of severity	23 %	63 %
Reduction of itching	38 %	72 %
Reduction of rash	38 %	72 %
Reduction of pain	54 %	83 %
Reduction of burning	63 %	85 %
Improvement quality of life	53 %	76 %
Occurred adverse events	80 %	71 %

Table 23: Data variant 1 – percentages –for the influence on drug perception.

Symptom	Old Drug	New Drug
Reduction of severity	23 of 100	63 of 100
Reduction of itching	38 of 100	72 of 100
Reduction of rash	38 of 100	72 of 100
Reduction of pain	54 of 100	83 of 100
Reduction of burning	63 of 100	85 of 100
Improvement quality of life	53 of 100	76 of 100
Occurred adverse events	80 of 100	71 of 100

Table 24: Data variant 2 – natural frequencies –for the influence on drug perception.

Data Variant 3:

Old drug: During the study, in 23 % of the cases the severity was reduced. In terms of symptoms, a reduction of itching occurred in 38 % of the cases, additionally rash was reduced in 38 % of the patients. Furthermore, pain was reduced in 54 % of the cases, as well as the reduction of burning in 63 % of the cases. The quality of life improved in 53 % of the patients. Adverse events were present in 80 % of the patients.

New drug: During the study, in 63 % of the cases the severity was reduced. In terms of symptoms, a reduction of itching occurred in 72 % of the cases, additionally rash was reduced in 72 % of the patients. Further more pain was reduced in 83% of the cases, as well as the reduction of burning in 85 % of the cases. The quality of life improved in 76 % of the patients. Adverse events were present in 71 % of the patients.

Data Variant 4:

Old drug: During the study, in 23 out of 100 patients the severity was reduced.

In terms of symptoms, a reduction of itching occurred in 38 out of 100 cases, additionally rash was reduced in 38 of 100 patients. Furthermore, pain was reduced in 54 of 100 cases, as well as the reduction of burning in 63 of 100 cases. The quality of life improved in 53 of 100 patients. Adverse events were present in 80 of 100 patients.

New drug: During the study, in 63 out of 100 patients the severity was reduced.

In terms of symptoms, a reduction of itching occurred in 72 out of 100 cases, additionally rash was reduced in 72 of 100 patients. Furthermore, pain was reduced in 83 of 100 cases, as well as the reduction of burning in 85 of 100 cases. The quality of life improved in 76 of 100 patients. Adverse events were present in 71 of 100 patients.

Questionnaire/ Scenario 2 [Prostate Cancer]:

Prostate carcinoma: Prostate carcinoma is the most common malignant tumor in men. In Germany, prostate cancer accounts for about 20 % of all new cancer cases. Erectile dysfunction and problems with urination occur. Pain is also

a typical symptom of this disease. The disease itself can spread in the body and is potentially fatal.

Old drug: During the study, 22 out of 100 patients survived this disease. In terms of symptoms, severe pain occurred in 35 out of 100 cases. Physical well-being improved in 44 of 100 cases, whereas social well-being improved in 40 of 100 cases. Complementary, emotional well-being increased in 37 of 100 cases. Side effects occurred in 77 of 100 cases. These were severe in 18 out of 100 cases.

New drug: During the study, 20 of 100 patients survived this disease. Among the symptoms, severe pain occurred in 42 out of 100 cases. Physical well-being improved in 58 of 100 cases, while social well-being improved in 43 of 100 cases. Complementary, emotional well-being increased in 39 of 100 cases. Side effects occurred in 87 of 100 cases. These were severe in 22 out of 100 cases.

Appendix C

C.1 Correlation matrix

Domain	General	Financial Matters	Car Driving	Sports and Leisure	Career	Health	Trust
General	*1*						
Financial Matters	*0.3450*	*1*					
Car Driving	*0.3800*	*0.5024*	*1*				
Sports and Leisure	*0.4153*	*0.5031*	*0.5135*	*1*			
Career	*0.4052*	*0.4740*	*0.4929*	*0.6072*	*1*		
Health	*0.3694*	*0.4703*	*0.4789*	*0.5120*	*0.5299*	*1*	
Trust	*0.3645*	*0.3819*	*0.3605*	*0.3901*	*0.3926*	*0.4272*	*1*

Table 25: Appendix: Correlation matrix between general and specific domains. All p-Values < 0.001. Shows the correlation (likeliness of giving the same answer) of the individuals' statements between the individual specific domains, where 1 = identical.

C.2 OLS regression on general and domain specific risk preferences

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Domain - Ordinal 0-10	**General**	**Financial Matters**	**Car Driving**	**Sports and Leisure**	**Career**	**Health**	**Trust**
Fear: Very Seldom	0.015	-0.170***	-0.068***	-0.085***	-0.106***	-0.188***	-0.064***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Fear: Sometimes	-0.257***	-0.110***	-0.170***	-0.224***	-0.173***	-0.115***	-0.099***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Fear: Often	-0.382***	-0.212***	-0.297***	-0.388***	-0.270***	-0.140***	-0.237***
	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.04)
Fear: Very Often	-0.411***	-0.350***	-0.365***	-0.522***	-0.464***	-0.298***	-0.388***
	(0.08)	(0.07)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)
Female	-0.768***	-0.853***	-1.004***	-0.846***	-0.715***	-0.705***	-0.269***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Age	-0.024***	-0.015***	-0.035***	-0.049***	-0.042***	-0.026***	-0.006***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Abitur: Father	0.210***	0.281***	0.098**	0.450***	0.300***	0.149***	0.629***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Abitur: Mother	0.203***	0.095**	0.027	0.338***	0.335***	0.168***	0.439***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Constant	6.584***	4.230***	6.247***	6.853***	6.334***	5.196***	4.038***
	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)
N	51669	50991	48708	50868	45116	51668	51716

Table 26: Appendix: OLS regression on general and domain-specific risk preferences.

.:= p < 0.1; **:= p < 0.05;***:= p < 0.01.*

C.3 Domain-specific risk preferences in the domains: Car; Financial Matters; Health; Sports and Leisure; Trust

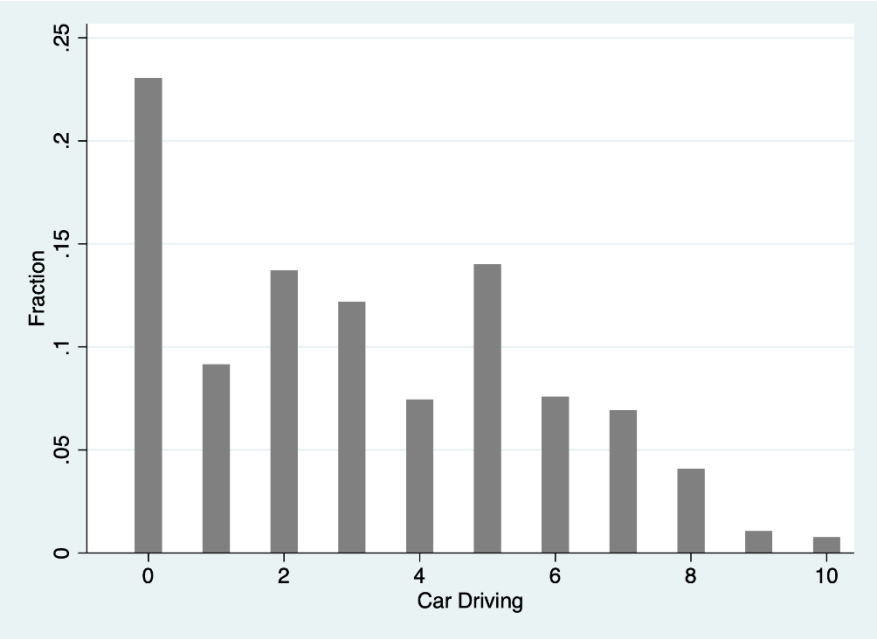


Figure 8: Car Driving distribution.

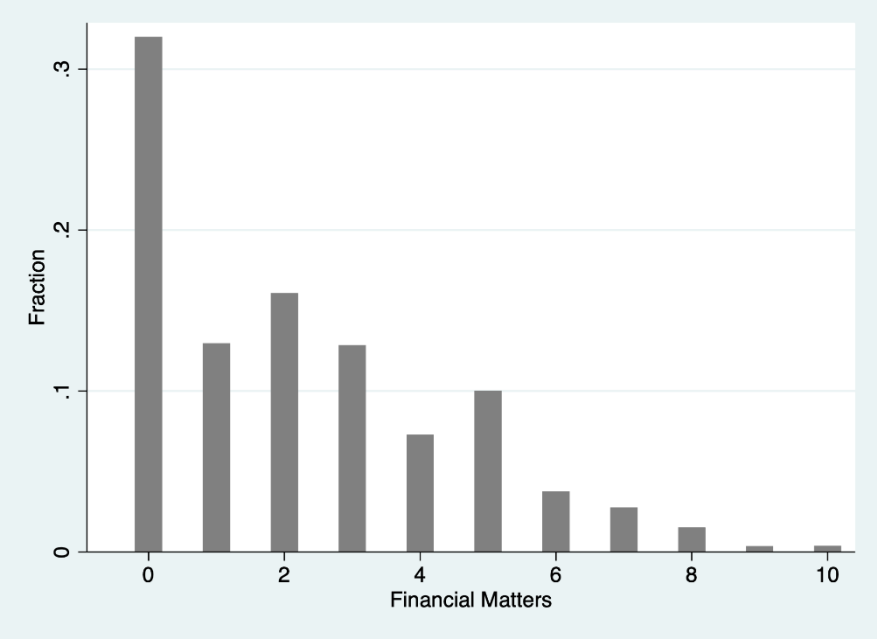


Figure 9: Financial Matters distribution.

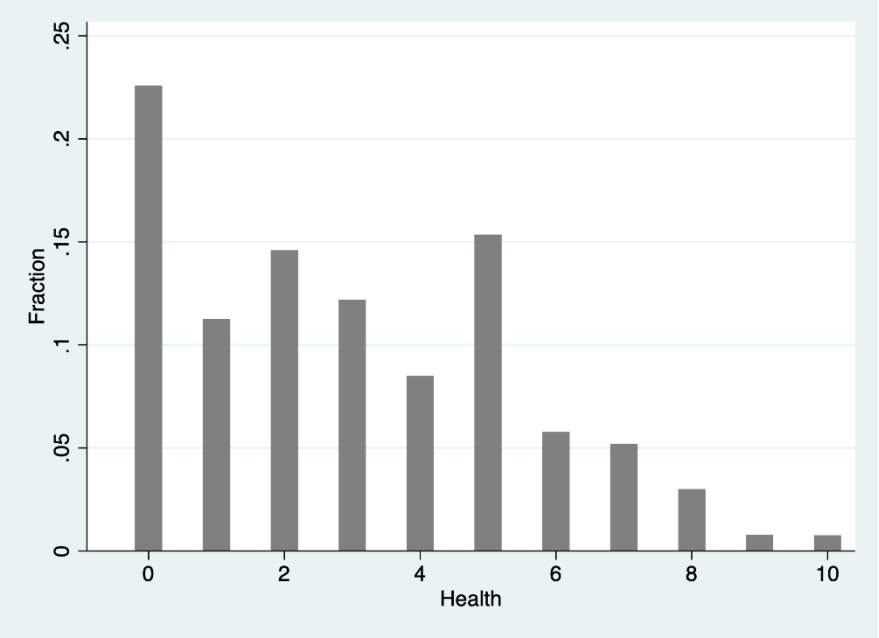


Figure 10: Health distribution.

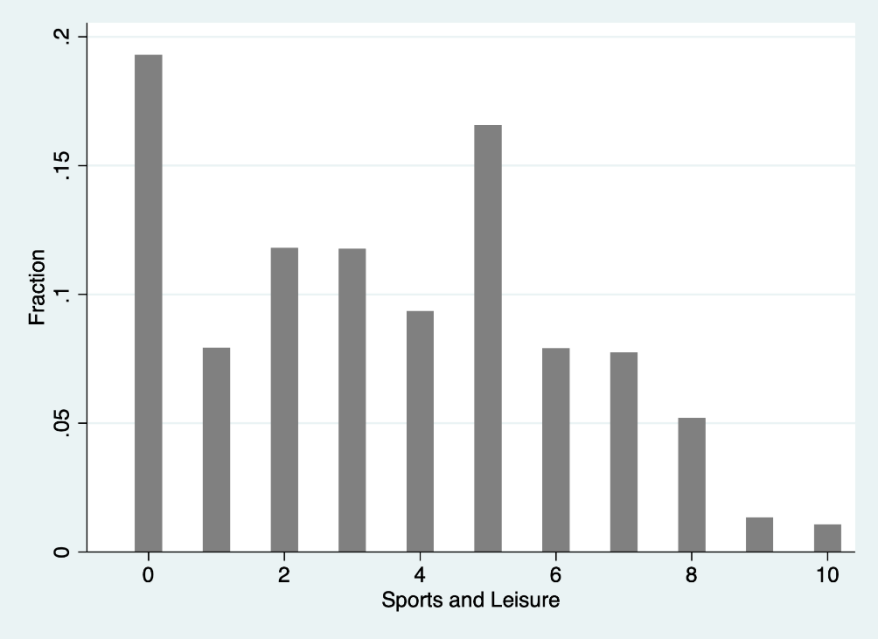


Figure 11: Sports and Leisure distribution.

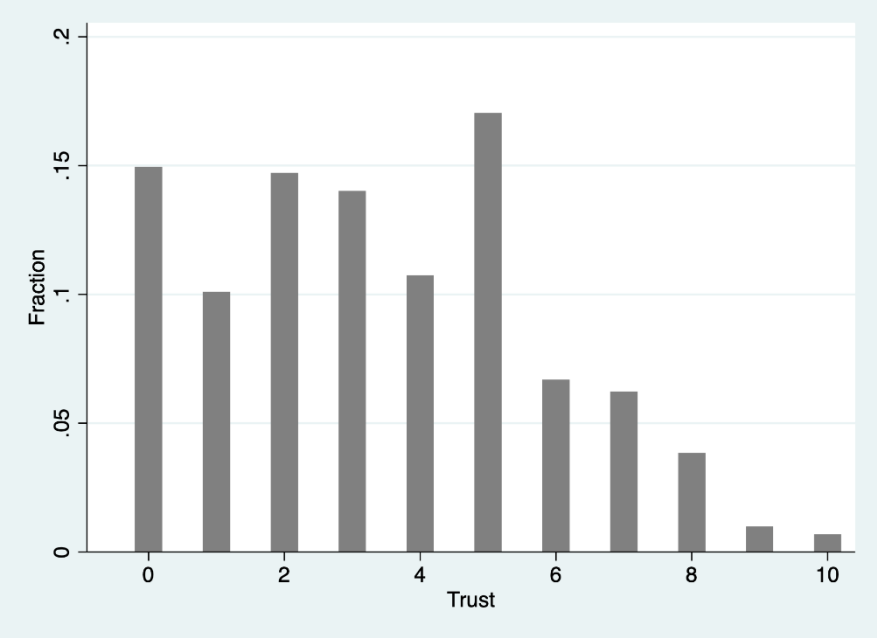


Figure 12: Trust distribution.