What Is Good Work?
Different Aspects of Labor Contracts in Theory and Experiment

Zur Erlangung des akademischen Grades eines
Doktors der Wirtschaftswissenschaften

(Dr. rer. pol.)

von der Fakultät für Wirtschaftswissenschaften
der Universität Karlsruhe (TH)

genehmigte

DISSERTATION

von

Dipl.-Volkswirtin Sabrina Bleich

Tag der mündlichen Prüfung: 9. November 2009
Referent: Prof. Dr. Siegfried K. Berninghaus
Korreferent: Prof. em. Dr. Hans J. Ramser

Karlsruhe, 2009

Danksagung

Während meiner Zeit an der Universität Karlsruhe habe ich viele Menschen kennen und schon bekannte noch mehr zu schätzen gelernt. An alle diese möchte ich nun ein Wort richten.

Herrn Professor Berninghaus möchte ich für die Gelegenheit danken, meine eigenen wissenschaftlichen Interessen zu entdecken und zu verfolgen. Auch hat es mir sehr viel Freude bereitet, mich in seiner Vertretung in der Lehre zu engagieren.

Zu denen, die mich schon etwas länger begleiten, gehört Herr Professor Ramser von der Universität Konstanz, meiner *alma mater*. Er hat mich schon während des Studiums als Mentor und als Betreuer meiner Diplomarbeit unterstützt. Durch die gemeinsame Beteiligung am DFG-Schwerpunktprogramm "Flexibilisierungspotentiale bei heterogenen Arbeitsmärkten" blieben wir stets in Kontakt, was in der Übernahme der Rolle des Korreferenten durch Herrn Ramser mündete. Ich bin ihm sehr dankbar für seinen Rat und die Unterstützung, die ich nicht nur, aber besonders im letzten halben Jahr meiner Promotionszeit erfahren durfte.

Herrn Professor Karl-Martin Ehrhart danke ich zuerst für die Übernahme des Prüfungsvorsitzes, jedoch noch mehr dafür, dass er stets offen für meine Fragen zu Spieltheorie und Datenanalyse war. Die Diskussionen haben meinen Horizont erweitert. Den Prüfungsvorsitz hat Herr Professor Schultmann bereitwillig übernommen, wofür ihm an dieser Stelle gedankt sei. Herrn Professor Güth vom Max-Planck-Institut in Jena danke ich für die Möglichkeit, bei meinen Aufenthalten in Jena in einem inspirierenden Umfeld arbeiten zu können.

Ohne die kollegiale und freundschaftliche Zusammenarbeit mit den Kollegen am Lehrstuhl für Wirtschaftstheorie und Statistik wäre das Projekt Promotion für mich wahrscheinlich anders verlaufen. Ich danke allen für die Unterstützung, die stets offenen Türen und den ehrlichen, persönlichen Umgang. Mein besonderer Dank geht an Marion Ott, die sich immer Zeit für meine Fragen nahm. Sie ist mir ein wissenschaftliches Vorbild und eine gute Freundin geworden. Christian Paul und Ralf Löschel danke ich für den nötigen Zug in der Endphase.

Ich danke meinen Eltern für bedingungslose Unterstützung und dafür, dass sie mich stets mit einem "Das packst Du schon." begleitet haben. Meinem Freund Christian möchte ich für seine Geduld danken und dafür, dass er erkannt hat, wie ich zu motivieren bin und mir damit half, eigene Zweifel auszuräumen und mich allen Widrigkeiten entgegenzustellen.

Stephanie Jahn hat sich die Zeit genommen, meine sprachlichen Fehler zu korrigieren, dafür möchte ich ihr danken. Alle übrigen Fehler sind mir selbst zuzuschreiben.

Zuletzt ein Wort an alle, die mich unterstützten und dies vielleicht noch nicht einmal wissen: Danke!

Karlsruhe, im November 2009

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α	parameter of production and motivation function
η	degree of intrinsic motivation
θ	skill parameter; high- ($\underline{\theta}$) and low-skilled ($\overline{\theta}$) with $\underline{\theta} < \overline{\theta}$
$\hat{\kappa}$	income tax for qualified workers; $\kappa = 1 - \hat{\kappa}$
τ	offered contract duration
φ	parameter of production function
e	effort
p	fraction of unmotivated agents
P	market price
q	production quantity
s	piece rate
$S(q)$	production function
w	lump sum transfer to agent, resp. fixed wage
w^c	market wage

Chapter 1

Introduction

The relationship between employer and employee is the subject of this thesis. Both sides of this partnership make decisions that have an influence on the production outcome as well as on their contract partner. An employer offers a work contract that consists of certain details, such as remuneration, working hours, output aims, duration of the contract and so on. The employee's decision depends on the details of the contract as well as on his given abilities, his education and his attitude towards work, towards this special job or the employer. If they expect to interact repeatedly, other factors like reputation building or trust and reciprocity can also influence behavior. The theoretical models laid out in this thesis, in combination with the experiments that study the same or similar phenomena, examine different parts of this bilateral relationship.

Traditionally, workers are assumed to be heterogenous regarding their qualification, in Chapter 2, we look at an additional, a special dimension of worker heterogeneity: In a labor market experiment with both sides represented by participants, workers decide themselves about their work effort in a real-effort task. Because both participants' payoffs only depend on the contract they conclude and are independent of the worker's actual effort, we interpret exerted effort as a consequence of intrinsic motivation. Up to date there are only experiments on the existence of intrinsic work motivation where the worker does not have a contract partner who is represented by an employer-participant offering a work contract. We expect workers to behave differently, when they do not just interact with the experimenter, but with a participant in the role of an employer.

A theoretical model of screening on intrinsic work motivation under endogenous and observable qualification choice is laid out in Chapter 3, first with continuous, then under a two-point distribution of intrinsic motivation. Here, the multiply defined term "intrinsic motivation" from psychology is transferred into the worker's utility function and a new selection problem arises as only qualification but not intrinsic motivation is observable to an employer.

Then we turn to long-term contracting under different degrees of contractual flexibility as the topic of Chapter 4: In addition to fixing wage details, a contract's duration becomes contractible but now the worker chooses his work effort after the contract is concluded. That means, the effort choice is not a part of the contract. This leads to a different situation than in the screening problems of Chapter 3: There is more room for reciprocal behavior between employer and worker, as the worker has an additional decision to make after the contract acceptance decision. With high wage flexibility inside an existing contract, employers are on the one hand able to react to changes in the labor market and on the other hand they can punish low efforts of workers by lowering wages. In the experiments of this chapter, we also want to examine whether the opportunity to contract for more than one period is used or if participants prefer to choose contract details anew each period.

The theoretical and experimental results bring workers' decisions on education and effort, the selection of workers by firms and long-term contracts into a new light. The question "What is good work?" can be interpreted in different ways: If an employer were asked, he would describe a worker doing a good job. A worker's answer might include the working atmosphere, job security, payment and other characteristics of the ideal job.

This thesis shows how these different answers can be combined in contracts that fulfill the expectations of both sides and that there is and also should be sometimes more than just financial optimization in a relationship between employer and worker.

Chapter 2

An Experiment On Work Motivation

A worker's skill level can influence production outcomes or at least production cost. This is an empirically approved fact[1] and is also explained in a series of economic models. In psychology, another characteristic of the employee is relevant: Work *motivation* over the years became an intensely researched field. Work motivation has an effect on a worker's attitude towards working and also on his effort (see e.g. Deci and Ryan (1985), p. 294).

The relevance of work motivation for a worker's behavior is acknowledged in psychology and there are many experiments on intrinsic motivation. In those experiments intrinsic motivation is taken as given and the experimenters test the influence of different surroundings or changes in the payment structure. The most widely developed type of experiments researches the influences of extrinsic incentives on intrinsic motivation, where for example pay on performance or goal-setting may have crowding effects.

To date, there are only a few experiments by economists, most of these also on crowding-out of intrinsic motivation by giving extrinsic incentives. What is missing, is a proof of existence of intrinsic work motivation, when participants are not just the contractual partners of the experimenter but decide before they produce (exert a real effort task) to accept a work contract offered by another

[1] See e.g. Chevalier, Harmon, Walker, and Zhu (2004).

participant. Hence, our experiment is in a labor market setting with lump sum payment. To avoid crowding-effects and to be able to identify intrinsic motivation, worker- and employer-participants' payoff does not depend on the actual working behavior of the worker-participant in the experiment. In the following an introduction to the concept of intrinsic motivation is given and the experimental literature is reviewed.

2.1 Different Views on Work Motivation

The following overview on the existing psychological theories on intrinsic motivation as well as on experiments by psychologists and economists is given to explain under which circumstances such an experiment has to be conducted and to show, why *this* experiment is a completely new approach.

Psychology tries to explain, which situations lead to higher or lower motivation and how motivation is influenced by working conditions. Economists are interested in the effects of motivation on the production outcome and on firms' profits and hence sometimes these disciplines do not talk about the same phenomenon when saying "intrinsic motivation".

2.1.1 Intrinsic Motivation in Psychology

Rheinberg (2006) states, that motivational phenomena come as "an activating focusing of the actual way of life to a positively valued target state."[2] The different justifications of motivated behavior can be divided into intrinsic and extrinsic motives. Woodworth (1918) was first to differentiate between an "activity running by its own drive" (p. 70) which is supposed to be intrinsically motivated, and activities that are done to reach an (extrinsic) aim. Unfortunately, this definition gives leeway to interpretation: Up to now there are several ways of defining intrinsic motivation that are used by the psychological community and there is no generally accepted theory, although all of them have common properties. To provide an insight into the discussion, we describe the most prominent ways to define intrinsic motivation: Intrinsic motivation...

[2] p. 15, translation by author.

... is what drives us during an enjoyable activity (Woodworth, 1918),

... follows from the need for self-determination and competence (Deci & Ryan, 1980),

... is another term for interest and involvement (Sansone & Smith, 2000),

... follows from agreement of means and ends (Shah & Kruglanski, 2000),

... can be described as goal orientation (Krapp, 1999).

The second way of differentiation was introduced by Deci and Ryan (1980). They started their research into intrinsic motivation in experiments with school children: The authors were interested in the effect of rewards (in their definition extrinsic motivation) on intrinsic motivation. The experiments were very stylized and later on other researchers, e.g. Cameron and Pierce (1994), criticized the missing applicability and transferability of results. The experiments consisted of three stages: In the first stage children were watched painting pictures (which all of them liked doing) and the time spent painting was recorded. The second stage was like the first, but children were proposed a reward for painting. Again painting-time was taken. At last they had to paint again but without rewards. Deci and Ryan (1980) found that these children painted less time in the post-payment part, than in the first and concluded that their intrinsic motivation to paint was "crowded out" by extrinsic motivation (rewards). One argument against their conclusions is that participants get a reward for doing a task they like. In a normal work context there is no need for additional incentives in such a situation, as the worker already works at his maximum. The authors defined intrinsic motivation as given by inherent needs for self-determination and competence. Extrinsic motivation, in contrast, is resulting from any kind of remuneration. With this publication, Deci and Ryan founded Cognitive Evaluation Theory (CET), which was based on the persons' perception of themselves (intrinsic) or an outside motive (extrinsic) as being the driving force. They amplified their definition of intrinsic motivation in their book (1985) to Self-Determination-Theory (SDT). According to SDT there is a need for social integration and taking over group standards. People want to identify with these standards and integrate them as their own. Although such standards come from outside the person, they get integrated in such a way as to become intrinsic motives.

Sansone and Smith (2000) took up a different stance on it and defined intrinsic motivation as interest. They described every activity which satisfies one's interest as intrinsically motivated. Kruglanski (1989), Shah and Kruglanski (2000), and Heckhausen (1989) in contrast defined intrinsic motivation as leading to a behavior with a direct relation of means and ends. Every activity that serves for more than one aim is in their terms not intrinsically motivated.[3] Activity, aim of activity and the consequences have to belong to the same theme for being intrinsically motivated. A student's behavior is intrinsically motivated if she, e.g, reads a text to solve a related problem afterwards. If she reads it to explain it to her friend, Shah and Kruglanski (2000) speak of extrinsic motivation.

Another differentiation is by Nicholls (1984), who looked for an application in educational psychology. He defined intrinsic motivation as orientation to learn and extrinsic motivation as orientation towards performance. This view of intrinsic motivation was extended by Krapp (1999), who included personal development goals into his definition of intrinsic motivation.

Although there are five ways to describe intrinsic motivation, there is, unfortunately, no common base to the definitions that can be seen as the true nature of it.[4] To avoid confusion, the terms intrinsic and extrinsic motivation are defined here as they will be used in this text:

> **Intrinsic Motivation** is based on the enjoyment of the task itself and felt during the process of the activity.
>
> **Extrinsic Motivation** is motivation from any kind of reward or separable aim that is followed by the activity.

These definitions can be derived from Thomas and Velthouse (1990). They define intrinsic task motivation as intrinsic motivation dependent on a certain individual task or project. This definition is also best suitable for a working place or an experimental laboratory and is in the following called work motivation.

[3]Satisfying greed for money is not an aim in their sense, especially as it is hard to sate.
[4]Sansone and Harackiewicz (2000).

A job or a real effort task is always limited to a certain area and in most cases the attitude towards one task cannot be completely generalized to the general working attitude of an individuum. According to Thomas and Velthouse (1990) task assessment by the worker himself is the "proximal cause of intrinsic task motivation and satisfaction". This assessment is only influenced by the personal preferences of the worker. These can also depend on factors outside the worker, like opinions of friends, family, co-workers or society. Like personal preferences, intrinsic motivation can change over time. This is reflecting part of SDT by Deci and Ryan (1985), when people take over norms to belong to a community.

2.1.2 Economic Experimental Evidence

Gneezy and Rustichini (2000) tried to solve the discussion between economists and psychologists on incentive pay. While the first claim, that increased incentives lead to higher effort, the second found the opposite: the crowding-out of motivation already mentioned. In a first series of experiments four treatments were run with a real effort task of answering questions from an IQ-test. The first group did only get a lump sum payment, in the second to fourth group each correctly answered question was rewarded additionally. Group four got a higher piece rate than the third group, and group two got a very low one. Gneezy and Rustichini found that highest performance resulted in the treatment without financial incentives, followed by three and four, and the fewest correct answers were given in the treatment with a very low incentive pay. They complemented their study with a field experiment: School children who collected money for a good cause were rewarded in a similar vein: They got zero, one or ten percent of their collection, paid by the experimenters. The lowest colleted sum was again yielded by the 1%-group. Hence, the authors resume, that whenever you need to pay per performance, better set out a high price as low incentives lead to worse results than just lump sum payment.

Pokorny (2008) did sort of a follow-up experiment. She gave two different real effort tasks to her participants: An intelligence test as Gneezy and Rustichini did and the search for "ones" and "sevens" in blocks of random numbers. These tasks were done under different degrees of incentive payment schemes (from none to high). Pokorny found an inversely U-shaped relation between incentives and effort, which contradicts the standard economic theory as well as motivation crowding theories[5], which would predict an increasing, respectively a U-shaped interdependence. These experiments show that there is a widespread range of results even in equal settings.

Falk, Gächter, and Kovács (1999) compare partner and stranger treatments of a gift-exchange game. Only in the partner treatments, they expect reciprocal behavior, but they observe this behavior under both matching protocols. They name it intrinsic motivation to act reciprocally. This can only occur when reciprocal behavior cannot be rewarded in the following interaction. Gächter, Kessler, and Königstein (2006) look at intrinsic motivation. They call it voluntary cooperation, if actual work effort is higher than contractually enforceable, and use a within-subjects design to test in a sequence of treatments how intrinsic motivation is influenced by the payment scheme. When coming back from an incentive scheme with bonuses or fines to lump sum payment, effort of agents is lower than in the initial lump sum payment treatment. This effect is even more pronounced, when agents are fined in the second part of the experiment. Reciprocity, which in this experiment is the positive relation between payment and effort, also diminishes after an experience of incentive pay.

Volunteering is sometimes seen as a signal for initiative at work. But if it is taken as a signal, people would volunteer to show initiative, irrespective of their real motivation (Katz & Rosenberg, 2005). As a consequence, the signal is diluted. It is also questionable whether motivation to volunteer can be compared to task motivation at the work place. Maybe the volunteer drew utility from acknowledgement or from doing a social job. Hence, volunteering does not need to be a signal of motivation. Also the empirical study by Frey and Goette (1999) using data from the Swiss Labor Force Survey, supports this view. The findings show that volunteering decreases, if financial rewards are offered. Even when these are as indirectly as a tax benefit, overall hours volunteered fall. A reason could be that volunteering cannot serve as a signal for intrinsic motivation any more, although in most cases rewards do not cover expenses. This could also be another example of payment crowding-out intrinsic motivation (to volunteer).

[5] Pokorny (2008), p. 253.

2.2 Intrinsic Motivation in a Labor Market Experiment

Opposite to different skill levels that can be reflected by different effort costs, intrinsic motivation cannot just be put into the functional interdependencies of a real-effort experiment. Intrinsic motivation has to be part of the results of an experiment and not of its assumptions. Every form of "motivational parameter" that is set by the experimenter can only induce extrinsic but not reflect intrinsic motivation. In this experiment, the payoff function of the agents depends positively on the wage and negatively on the production cost to an agent. If he draws further utility from the task itself (is intrinsically task motivated), depends on the participant. That means we assume the degree of intrinsic motivation for our task to be innate and brought to the experimental laboratory by the participants themselves.

We want to look at task specific intrinsic motivation and its interdependence with skill which is in our experiment chosen by the worker participants. Our subjects first choose their skill level. Qualification cost are a fraction of their contractual payoff. A higher skill level leads to a simplification of the real effort task, which means there are fewer steps of production left to fulfill the task than for a participant who did not invest and cost of producing one unit are lower.[6] We let them choose their skill-level to give them an additional degree of self-determination in addition to having the possibility to just reject a contract offer. This increases autonomy, which is one of the core job characteristics that is necessary to induce high work motivation as stated by Hackman and Oldham (1980).

As we need comparability between subjects, we chose a task such that all of the subjects have the same ex ante chance to finish it. It is unrelated to specific skills of participants. We also give direct feedback in showing the tasks' solutions to the participants, which is also demanded by Hackman and Oldham (1980) as a basis for intrinsic motivation. To exclude that profit orientation has an influence on the worker's decision to exert effort and also on crowding effects on intrinsic

[6]This reflects the traditional way to model qualification: High-skilled workers have to bear lower production cost than low-skilled workers.

motivation, he and his employer are both paid according to the contract they concluded irrespective of the worker's effort.

In a second treatment, we are interested in the influence of social aspects on intrinsic motivation. Some theoretical models (e.g. Besley and Ghatak (2005) and Murdock (2002)) explain intrinsic motivation to be linked with (social) aims of the firm the agent is employed at. There is a strand of literature about higher than normal intrinsic motivation of workers in "jobs with a mission", namely any kind of voluntary job for some social organization. This kind of motivation is described by Francois (2000) (p. 278). He terms this phenomenon "public service motivation". It exists if a worker is motivated by a certain social aim of the organization he works for so that his incentive constraint is altered and his incentive compatible wage falls. Also Quinn and Staines (1979) found in their 1977 survey in the United States 49.6% of the respondents agreeing to the statement: "What I do at work is more important to me than the money I earn." In this survey, members of the workforce in different occupations were asked, not only workers in social jobs. Preston (1989) did an econometric analysis on the 1980 Survey of Job Characteristics (USA) and found a highly significant non-profit wage differential of -18% for managers and professionals. This differential varies in its significance when controlled for industry, job autonomy and flexibility but remains negative and significant. These results support the author's hypothesis that employees of non-profit organizations donate part of their wage to the good cause. That the effect is more significant for leading positions, results from a more direct link of effort and organizational outcome.

Other economic experiments put their focus on crowding-out of intrinsic motivation under different incentive schemes and thus use a within subjects design, whereas we compare the behavior of different participants in the same situation.

2.2.1 Experimental Design

The worker's payoff depends on the contract he accepts and on his chosen skill-level. If he rejects the contract that is offered by the employer, his payoff is zero. A contract consists of a lump sum payment w and a production quantity q, both are enforceable. Low-skilled workers have a cost of producing per quantity unit (QU) of 7 monetary units (MU), these are for high-skilled workers only 5 MU/QU. This leads to workers' payoffs:

$$P^L(w, q) = w - 7 \cdot q;$$

$$P^H(w, q) = w - 5 \cdot q,$$

with superscripts L and H denoting low- and high-skilled workers. The principal's payoff from a concluded contract is:

$$\Pi(w, q) = 20 \cdot \sqrt{q} - w,$$

and zero, if the worker rejects the contract offer. As the workers in the experiment have to fulfill a real effort task, it is reasonable to assume values that correspond to the task. 7 MU/QU and 5 MU/QU are chosen as every final product consists of 7 parts for low-skilled and 5 parts for high-skilled agents. More detailed descriptions of the task can be found in section 2.2.2.

The setting of the experiment consists of two participants per session assigned to the roles of worker and employer. Workers are low-skilled at the beginning and then decide about becoming high-skilled or not. Education is costly and becoming high-skilled leads to cost of 20% of the worker's contractual payoff. The employer offers a contract to the worker from a given menu of contracts. The worker accepts or rejects the offered contract. If a contract is accepted, the agent produces, i.e. he can work on the contracted number of tasks (q) or wait until the given production time (7 minutes per q) elapses. In both cases, he is paid according to the concluded contract, depending on his qualification decision, qualification cost are subtracted. Hence, payoffs are not influenced by the agent's effort in production. Whether the worker fulfills this task has no effect on his own or the principal's income, but it is noted by the experimental assistant.

In this setting a worker has no financial incentive to work. We tried to model a job with lump sum payment and no control of effort. In reality one will find very few jobs with absolutely no control or no possibility for a principal to relate the outcome to the effort of his agent. But in most jobs there will be at least some part of outcome that cannot be related to effort. So, if a worker actually "works" in this experiment, he will not be extrinsically motivated by his payment structure but intrinsically motivated by himself or the task. We chose to fix the time worker participants have to stay at the laboratory depending on the accepted contract as in a normal working place the time a worker spends at his job is the easiest to observe.

For both skill levels of the worker there is a given menu of four contracts from which the employer chooses a contract to simplify the decision of the employer and to make results of different sessions comparable. As the main focus of the experiment lies on the worker's behavior, this simplification is not seen as critical for the experiment's results. Table 2.1 lists the possible contract offers.

Table 2.1: Available Contracts in the Experiment

qualification of agent...	contract	$(w;q)$	P	Π
...low-skilled				
	N1	**(8;1)**	1	12.00
	N2	**(14;2)**	0	14.28
	N3	**(23;3)**	2	11.64
	N4	**(34;4)**	6	6.00
...high-skilled				
	H1	**(11;2)**	1	17.28
	H2	**(19;3)**	4	15.64
	H3	**(20;4)**	0	20.00
	H4	**(35;5)**	10	9.72

Only the bold entries are visible for the participants of the experiment. During the decision part of the experiment the participants can use a calculator on the computer screen to calculate their own as well as their partner's payoffs. As this contract offer is not in the main focus of the experiment, we tried to make up four different contracts per type with similar characteristics:

N2 & H3 These are the optimal contracts: Profit is maximal. Agents get their outside option of zero and the principal keeps the whole profit.

N1, N3, H1 & H2 Contracts that share the profit: Agents get less than a principal. The principal's gains lie between the extreme contracts.

N4 & H4 Nearly equal split: Contracts with highest payoff for agents and lowest for principals.

With this selection of contracts the employer can choose what he wants to offer to the worker and the behavior of agents with different payoffs can be observed. The contracts are ordered by quantity. The range of quantities is the same for both types but at different levels. We decided to do it this way because the contracts we wanted to use do not differ much in their according lump sum transfers and this could have led to some presumptions by the participants that were not originally intended. We only gave the bold information to them and did not give any labels like "equal split" to the contracts in order to prevent any influence on the decisions.

The second treatment of the experiment (*SOC*, social) we conducted to test whether there can be social intrinsic motivation in a laboratory situation of this kind. Again, the payoffs of the principal and the agent do not depend on the working effort of an agent but only on the concluded contract. In addition to the rules described earlier, for every task that is completely solved by the agent, the experimenter makes a contribution to a good cause, namely SOS Kinderdorf e.V. It is active on behalf of the socially disadvantaged all over the world, especially children.[7] The agents are given an extra EUR 1.50 to put into an original donation box of SOS Kinderdorf e.V. to guarantee that the amount is actually donated. In this treatment we expect to observe even higher intrinsic motivation, either in form of more participants working, a higher completion rate or in accepting contracts with lower utility levels. Although the worker again does not profit financially from fulfilling the task, he profits because he is even more intrinsically motivated, which would support the empirical findings already mentioned.

At the end of the experiment all participants are given a questionnaire about

[7]This organization was chosen because it is well known in Germany and there is no negative press on it. In addition, it does not work for people with certain diseases so that some participants could feel more or less in favor of it.

their reception of the situation and in case of the "good cause" treatment, on their opinion about SOS Kinderdorf e.V.

2.2.2 The Real Effort Task

A task for an experiment to study intrinsic motivation has to be interesting and at the same time not too difficult, so that participants are able to solve it.

> "The more interesting a task for the agents, the higher is their intrinsic motivation to perform well." (Frey (1997b), p.431.)

It should also be hard enough so that it stays challenging over the whole run of the experiment. Putting together the parts of a "Soma-Cube" was chosen for the task. In Figure 2.1 there is an illustration of the seven parts of the puzzle. As the interest will fall when a certain shape has been built once, participants will be given different shapes that can be built with the parts of this puzzle. The number of shapes to built is set by the contracted quantity. For every shape a worker has seven minutes.

After seven minutes the worker is shown the solution and given a picture of the new shape to build. Again, whether he finishes a shape or not, does not change his or the employer's income. The agent could also just wait until seven minutes times the production quantity have passed and will be paid exactly the same amount.

As already mentioned, the worker can decide whether to invest in "qualification" or not: If he invests, some pieces are put together. The shape to build will then only consist of five instead of seven pieces (cost per quantity unit falls from 7 MU/QU to 5 MU/QU). The worker profits because it will be easier to solve the task and he will save production costs as they depend on the pieces necessary to put together a shape.

2.2.3 Experimental Procedure

The experiment took place in November 2007 at the University of Karlsruhe[8] with 72 participants in 18 sessions per treatment. Participants were undergrad-

[8]The experiment was run by means of the Deutsche Forschungsgemeinschaft.

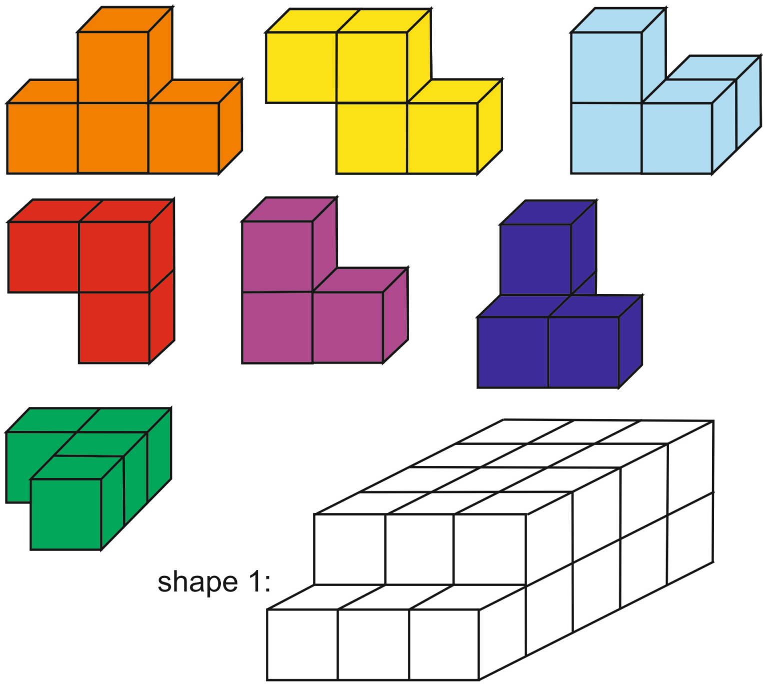


Figure 2.1: Exemplary Soma-Shape

uate students of different subjects recruited randomly through our database of potential participants. Only male participants were invited to avoid differences with respect to interest in the task between men and women. The two participants of each session were seated in different rooms, not meeting each other beforehand. This was done to guarantee anonymity and avoid coordination between subjects. Also, we did not want the worker to feel controlled by the employer during the production phase. Sessions took 30 minutes on average. The length depended on the contract that was chosen, as there were given 7 minutes of production time per contracted piece of output. Participants in the role of an employer were paid and could leave after the acceptance decision of the worker-participant and after filling in a questionnaire. So there was no feedback on worker's production to the employer. The workers also had to fill in a questionnaire after the experiment. A translation of the questionnaire and the instructions for a worker can be found in the Appendix (2.4.1 and 2.4.2). The anonymous payoff was on average 6.18 (6.29) EUR for employers in the normal (social) treatment and 10.11 (10.72) EUR was the respective average payoff to workers. Workers in the social treatment donated 48 EUR to SOS Kinderdorf e.V.

2.2.4 Results

2.2.4.1 Workers' Qualification Decisions

The qualification decision of workers in the experiment cannot lead to negative payoffs: As qualification cost are a fraction of future payoff, they only decrease their gain. If assumed that all available contracts are offered at the same probability, in both treatments workers should choose to become high-skilled as the expected payoff is higher[9]. A low-skilled worker's expected payoff is:

$$E[P^L] = 0.25 \cdot (1 + 2 + 0 + 6) = 2.25$$

The expected payoff for a high-skilled worker net of qualification cost is:

$$E[P^H] = 0.8 \cdot 0.25 \cdot (1 + 4 + 0 + 10) = 3$$

Hence, becoming high-skilled is in expectancy more profitable than staying low-skilled. If workers decide in treatment *SOC* with respect to expected contract quantities (more tasks to solve lead to more chances for donation), they should also decide in favor of becoming high-skilled, as the maximum number of tasks is five instead of four for low-skilled workers. The first hypotheses to test are:

H_1A: Workers decide in favor of becoming high-skilled.

H_0B: There is no difference in qualification between treatments.

83.3% of workers in treatment *NORM* (normal) and 77.8% in *SOC* decided in favor of becoming high-skilled. There is no statistical significant difference (Fisher exact test; $P = 0.500$) between treatments in qualification.

RESULTS A AND B *The majority of workers in both treatments is high-skilled. There is no significant difference between treatments. Thus H_1A is supported and H_0B cannot be rejected.*

[9] Compare Table 2.1 for payoffs from contracts.

This reflects the results of an experiment by Shapira (1976), where participants first chose from difficulty-ranked Soma-puzzles which one to solve, and then made a preference-ranking of the remaining puzzles. In a treatment with completion contingent payment, they chose the easier puzzles while in a treatment with a lump sum payment (as in our experiment), participants chose higher levels of difficulty. So workers in our experiment could also have been influenced by the payment scheme and have chosen to become high-skilled, expecting more challenging tasks.

2.2.4.2 Contract Offers and Acceptance

Profit maximizing employers offer contract $N2$ to a low-skilled and contract $H3$ to a high-skilled agent. These contracts contain the profit maximizing quantities and leave workers with their outside option, which leads to maximum payoff for employers:

H_1C: Employers' contract offers are $N2$ and $H3$.

To categorize contract offers for both skill levels, we labeled contracts according to the (approximative) distribution of the pie $(\Pi(w,q)+P(w,q))$.

Division	Contract high	Contract low
100: 0	H3	N2
95: 5	H1	N1
80:20	H2	N3
50:50	H4	N4

There is no significant difference in contract offers between treatments (χ^2-test; $\tilde{\chi}^2_{(df=3)} = 0.917$). In Figure 2.2 the distribution of contract offers is shown. Most times, a 80:20 contract is offered, followed by 100:0 and for *SOC* 50:50. Maybe the fear of rejection led employers to offer 80:20 more often than the efficient contract with 100:0. The higher fraction of 50:50 offers in *SOC* could be influenced by social commitment of employers, but there are two different effects: On the one hand, an employer could expect his worker to accept less generous offers than in *NORM* because of his attachment to the "good cause", on the other hand, he could have chosen to offer the contract with maximal quantity to yield high donations to SOS Kinderdorf e.V.

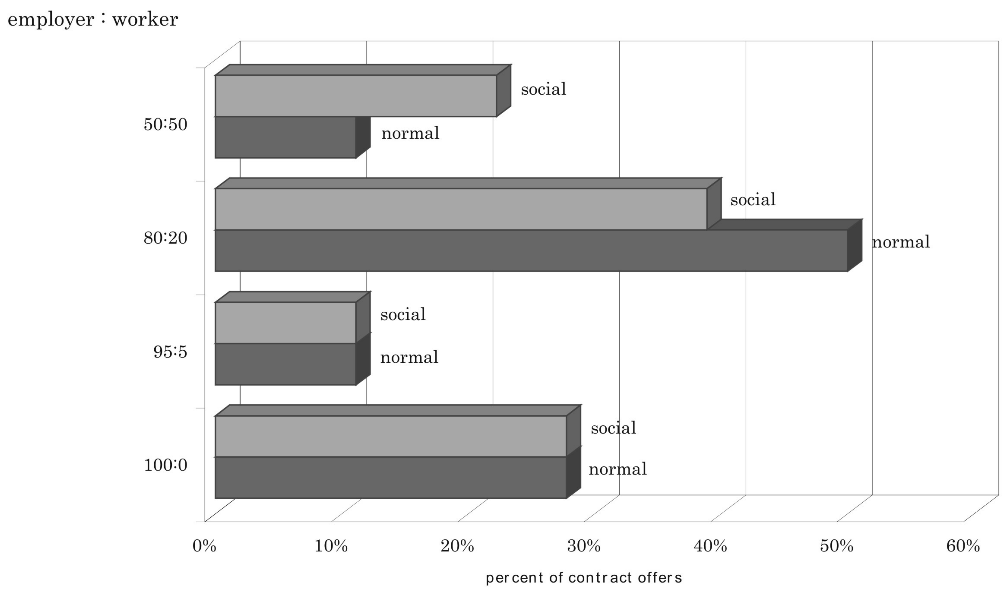


Figure 2.2: Contract Offers by Division of Pie in *SOC* and *NORM*

RESULT C *Employers' offers are not optimal. H_1C is not supported.*

Workers should accept every contract with a positive payoff as the contract that gives them at least their initial endowment is combined with spending time at the experimental laboratory and should (without any intrinsic motivation) result in a lower utility than rejecting the contract. As there are contract rejections, it is checked whether only contracts with a positive payoff are accepted. So the next hypothesis is:

H_1D: Workers accept all contracts with positive payoff.

In Figure 2.3 accepted contracts are depicted with respect to the split of net gains. Under 100:0 a higher percentage of contracts is accepted in *SOC* than in *NORM*. This may be due to the workers commitment to the "good cause", but

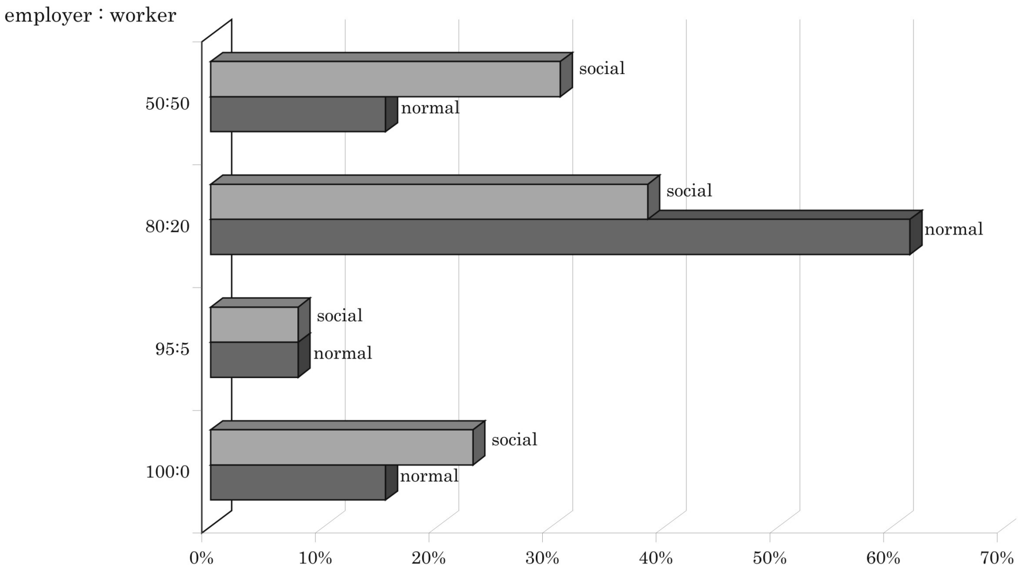


Figure 2.3: Accepted Contracts by Division of Net Gain in *SOC* and *NORM*

the difference in accepted contracts is not significant (χ^2-test; $\tilde{\chi}^2_{(df=3)} = 1.559$). If contracts with positive and zero payoff are compared, in *NORM* there is a statistical significant difference at the 5%-level (Fisher exact test; $P = 0.044$). In *SOC* there is no difference (Fisher exact test; $P > 0.334$). We interpret this as an increased tendency to accept zero payoff contract offers, when a good cause can be supported.

> RESULT D *In* SOC *workers' contract acceptance does not depend on the question whether the payoff is positive or zero. H_1D cannot be supported for treatment* SOC *but not for* NORM.

2.2.4.3 Intrinsic Motivation

After comparing the rational benchmark with the experimental results, the main focus of the experiment, workers' intrinsic motivation, shall be analyzed. In this experimental situation, there is no incentive for workers to actually produce: They get their contractual fixed lump sum payment independent of their production behavior. So if participants in the role of a worker decide to produce, they need to be intrinsically motivated.

> H_1E: There is intrinsic motivation in form of participants in the role of a worker trying to solve the task.

As 100% of participants (all in *SOC* and *NORM*) in the role of a worker actually tried to solve the task, there is no need to test if there is intrinsic motivation. As most of the worker-participants answered that they enjoyed the task (88.2% in *NORM* and 83.3% in *SOC*), emotions like curiosity, fun, and interest are also explaining factors but as they do not result from any extrinsic incentives and depend on the participant, they can be subsumed under intrinsic motivation. The only extrinsic influence is the presence of a student assistant that handed the new parts and wrote down, whether the participant worked (The writing down was not announced to the participant.). According to social facilitation theory (Zajonc, 1965) the presence of another person has a positive effect if the task is simple and has a negative effect if the task is hard. As this task was not too complex, the presence should have increased effort but cannot be held responsible for the whole 100%. As this method is applied by most psychological experiments on intrinsic motivation too, a possible bias is contained in all of these studies and does not decrease comparability.

RESULT E.1 *Workers in the experiment are intrinsically motivated.*

According to (Murdock, 2002) intrinsic motivation of workers is even higher when they work for a good cause, so in treatment *SOC* intrinsic motivation is expected to be even higher than in *NORM.* But as already mentioned, the production rate is 100% in both treatments and there cannot be any increase from *SOC* to *NORM.* In fact, although they had fewer parts, the puzzles for the high-skilled seemed more difficult than those of low-skilled: In *NORM* 61.1% compared to 52.0% and in *SOC* 83.3% compared to 60.7% of the low, respectively high-skilled workers' puzzles were completed. The differences between skill-levels and between treatments are, based on t-tests, insignificant. If one goes back to Result D, there was a difference in contract acceptance in *NORM* with respect to workers' payoff and no difference in *SOC*. This leads to the conclusion that workers in the social treatment accepted contracts irrespective of their own payoff, to work for the good cause. So the increase in intrinsic motivation from *NORM* to *SOC* is not in working behavior but in contract acceptance.

RESULT E.2 *There is no difference in working on the task between the treatments. But higher intrinsic motivation is reflected by a higher contract acceptance rate in treatment* SOC.

Figure 2.4: Question 2, Worker

2.2.4.4 Questionnaire Data

After the experiment, both participants in each session filled in a questionnaire with questions about the experimental situation. 88.2% (83.3%) of workers in *NORM* (*SOC*) enjoyed the task. Although neither their own nor the employers payoff depended on production activities, 26.7% (38.9%) felt obliged to work (Figure 2.4). This difference is not statistically significant (Fisher exact test;

$P = 0.387$). As already argued, these numbers cannot account solely for the high percentage of working participants.

Although Figure 2.5 seems to show a much higher rate of participants experiencing the task as rewarding in *SOC*, there is no statistical significant difference between treatments (Fisher exact test; $P = 0.088$).

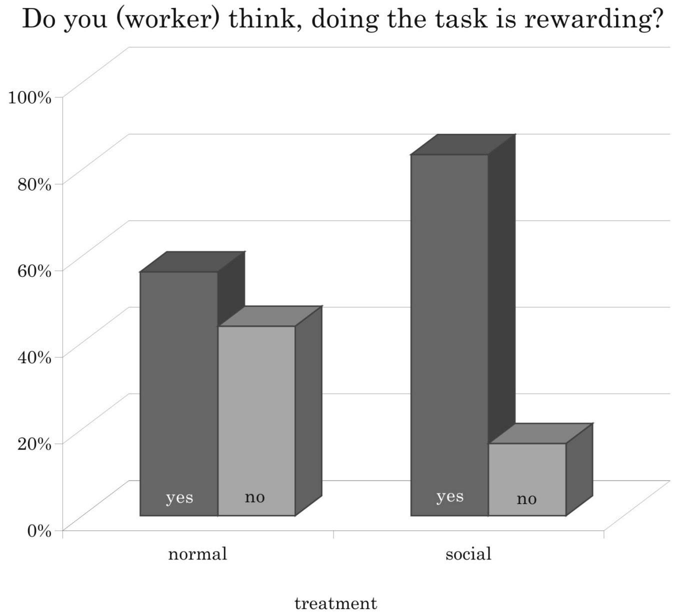


Figure 2.5: Question 3, Worker

Answers to the question *"Describe your considerations in selecting your contract offer."* that the employers were asked, can be divided into four categories: (1) I considered only my own payoff. (2) I considered my own and the worker's payoff. (3) I considered my own, the worker's and the payoff to SOS. (4) I considered only the worker's payoff. In *NORM* the majority of 76.5% employers answered (2), answers (3) and (4) were only given in *SOC*. Figure 2.6 shows the distribution of employers' answers for both treatments. The distributions do not differ significantly (χ^2-test; $\tilde{\chi}_3 = 3.157$).

88.2% of the employers in *NORM* expected their worker to produce. In *SOC* only 77.8% believed in the motivation of their worker. The difference between treatments is not significant (Fisher exact test; $P = 0.50$). With these answers,

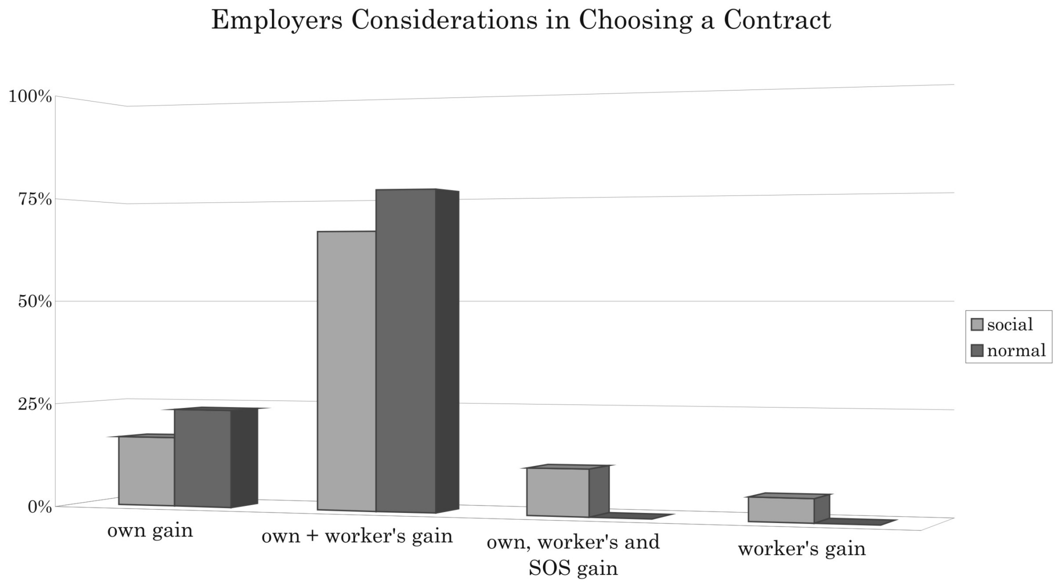


Figure 2.6: Question 1, Employer

employers state their expectancy of worker-participants' intrinsic motivation. To the question if they would produce themselves, 76.5% of employers in *NORM* answered "yes" and in *SOC* even 83.3%.[10] All of the participants in *SOC* knew SOS Kinderdorf e.V. beforehand and 91.7% had a positive impression of their work, the rest did not give an answer.

2.3 Conclusion

Experimental evidence for intrinsic motivation in a labor market setting with lump sum payment is found. Participants were highly intrinsically motivated such that they already worked at the maximum with low contract payoffs and no social incentives. A difference in worker or employer behavior between treatments cannot be stated since observed motivation was already maximal in *NORM*. Workers' contract acceptance in the social treatment did not depend on their payoff in contrast to the normal treatment: In the situation without

[10]No statistically significant difference; Fisher exact test: $P = 0.466$.

social incentives, workers differentiated between contract offers with positive or zero payoffs. If they have the possibility to donate, the contract acceptance is independent from their own payoff.

The experiments on intrinsic work motivation have a very clear result of 100% of the participants behaving motivated, as they try to solve a task without being rewarded for it. What could have driven this result, is that participants felt observed by the student assistant, who noted if they worked, such that they could have done this because of moral obligation. In the already mentioned studies by psychologists[11], this is a quite common way to conduct motivation experiments and even in the experiments of the critics, like Cameron and Pierce (1994), this method is applied. Hence, if there is an influence of observation on exerting effort, it is prevalent in all experiments on motivation and thus seems to be considered negligible by the scientific community.

If we want to avoid the participants feeling observed, there is a measurement-problem: Computerizing the task does not overcome the problem as participants know that the experimenters log their entries. Sticking to a manual task and using video cameras to control their behavior has the same effect, if participants know about it and is illegal, if they do not. Self reports by players are not trustworthy as these have the same effect of control. If there was a way to collect participants' agreement to be recorded during this actual experiment, we could test the robustness of our results, but therefore we also needed a proof that participants consider themselves as unobserved and this again raises new problems.

Another reason for all participants working could be, that they wanted to avoid boredom, as they were only allowed to leave the laboratory after the contracted time (determined by units of output) elapsed. This was done to keep comparability with a normal work situation of predetermined working hours. As intrinsic motivation can only exist for an interesting task (see e.g. Deci and Ryan (1985), p. 32f.; Deci (1971), p. 108), we did not choose something like counting zeros in blocks of numbers. The task itself may also have led to such a high number of working participants[12], but actually, this is intrinsic motivation

[11] See Deci, Koestner, and Ryan (1999) for some examples.

[12] 88.2% of workers in *NORM* and 83.3% in *SOC* answered in the post experiment question-

itself and by using a dull task, we had excluded the possibility to show motivated behavior from the first.

This experiment's description and implementation shall serve as a first example to do economic experiments on intrinsic work motivation. We wanted to give a summary of psychological findings relevant for running motivation experiments and show the problems, that need to be solved. Here, we tried to cope with most of the challenges but could not manage all of them, which is mainly due to legal restrictions.

naire that they enjoyed the task.

2.4 Appendix

2.4.1 Instructions for a Worker

You are taking part in a decision experiment with two participants. During the experiment you can earn money. How much you earn depends on your decisions and on the decisions of the other participant. Every participant is seated in a separate room. You were randomly given the role of a worker. You will stay in this role for the whole experiment. There will be one interaction with the participant that represents the employer. Your initial endowment is 5 monetary units (GE).

Run of the Experiment

At the beginning the worker is low-skilled. He can invest in his qualification and will be high-skilled afterwards. This comes at cost K. The worker can produce units of output the cost of production is born by the worker. A low-skilled worker incurs higher production cost per unit of output than a high-skilled worker. As soon as the worker has made his qualification decision, this decision is told to the employer. For each qualification level of the worker, the employer can choose from four different contracts consisting of a lump sum transfer L and a production quantity M. The employer decides which of the four contracts is offered to the agent. The worker is informed about the contract and decides about acceptance of the offered contract. An accepted contract is binding for both sides. After accepting the worker produces according to the contract. He puts together M figures from parts, with every figure representing a task. The worker has 7 minutes for every task. If he cannot finish his task within this time, the task is valued as complete (but not finished by hand). The solution to the task is shown and he can start with the next task. Actually finished tasks result in a donation to SOS Kinderdorf e.V. If the given time ($M \times 7$ minutes) has elapsed, the experiment is finished. Worker and employer are paid anonymously.

Interaction

1. The worker decides about his qualification. Qualification costs are 20% of his payoff from the future contract($K = 0,2 \cdot E_H$). That means if $E_H = 0$, qualification costs $K = 0$. If he rejects the offered contract, qualification cost is zero. The payoff from a contract to a high-skilled worker is:

$$E_H = L - 5M$$

A low-skilled agent's payoff from a contract is:

$$E_L = L - 7M.$$

At the bottom of your computer screen there is a button to call a calculator which you can open at every time during the experiment.

2. The employer is instructed about the worker's qualification (high- or low-skilled). His gain is:

$$\Pi = 20 \cdot \sqrt{M} - L.$$

The employer has four contracts (according to the worker's qualification) to choose his contract offer from.

qualification of agent...	contract	L	M
...low-skilled			
	N1	**8**	**1**
	N2	**14**	**2**
	N3	**23**	**3**
	N4	**34**	**4**
...high-skilled			
	H1	**11**	**2**
	H2	**19**	**3**
	H3	**20**	**4**
	H4	**35**	**5**

3. The worker is instructed about the contract offer and accepts or rejects it.

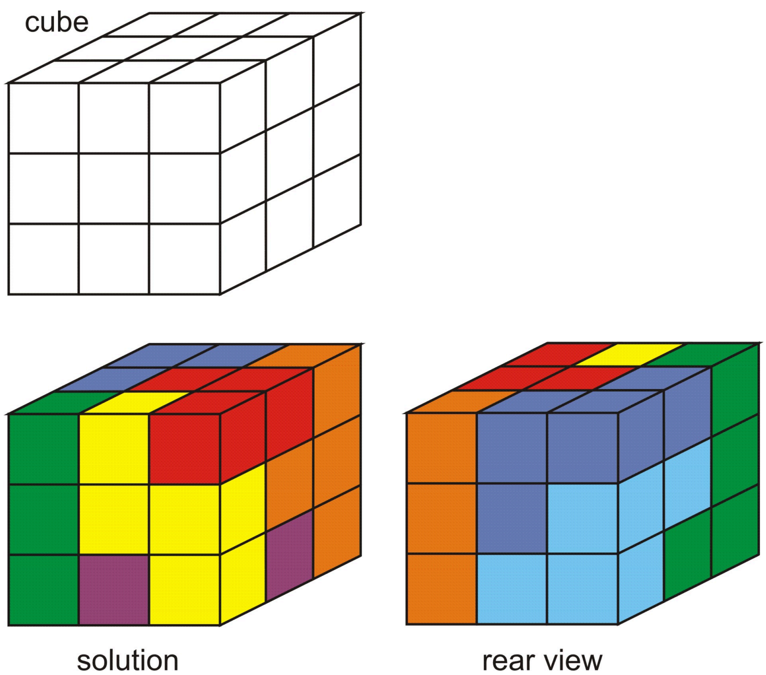
If the worker accepts the offer, the feasible quantity is produced according to:

Production

On the computer screen you will see a task. This form was built from parts. It is your task, to rebuild the form by hand. If you actually build these forms is your personal decision.

If you are low-skilled you receive 7 parts, as a high-skilled worker you get 5 parts, every piece in a different color. The number of tasks is the contractually fixed M.

For *every* form you have 7 minutes. At the top of the computer screen the 7 minutes are counted down. If this time has elapsed, you are automatically shown the solution of the task. To built the next form, you get new pieces. By pressing "OK" the next task is shown and the next 7 minutes count down.



Your and the employers payoff do not depend on trying to solve the task or on just waiting until production time ($7 \times M$ minutes) is over. For every task you have finished you get an extra EUR 1,50 to put into the donation box of SOS Kinderdorf e.V. The experimenter decides whether the task is finished or not. You can see the donation box next to you. It will be sent to SOS Kinderdorf e.V. at the end of the experiments.

Example

You are high-skilled and accepted a contract with $L = 60$ and $M = 10$. You finished 3 forms during production time. Your payoff is: $E_H = 60 - 5 \cdot 10 = 10$. Your qualification costs are $K = 0,2 \cdot 10 = 2$. Your payoff including the initial endowment is: $E_H - K + 5 = 10 - 2 + 5 = 13GE$. As you finished 3 forms, you put $3 \times$ EUR $1,50 =$ EUR $4,50$, which you get in addition from the experimenter, into the donation box. The employer gets: $\Pi = 20\sqrt{M} - L = 20\sqrt{10} - 60 \approx 3,25GE$.

Payment

You are paid at the end of the experiment. Payment is independent of the number of actually built forms by the worker. Payment is determined only by the accepted contract and the initial endowment. In case you invested in high qualification, qualification costs are subtracted.

For every GE you get EUR 1,40. Payment is individually and anonymously.

Before the experiment starts, you will be asked some questions on the computer screen about the rules. Please ask the experimenter, if you do not understand any of the rules .

At the end of the experiment you get a questionnaire. Please fill it in and leave it at your table.

2.4.2 Questionnaires

Worker

1. Did you enjoy the task itself?

2. Did you feel obliged to work?

3. Is the task rewarding?
4. Did you know SOS Kinderdorf e.V. before the experiment?
5. In case you answered “yes”: Do you have a positive impression of the organisation’s work?

Employer

1. Describe your considerations in selecting your contract offer.
2. Do you think the worker actually produces?
3. Would you produce in his place?
4. Did you know SOS Kinderdorf e.V. before the experiment?
5. In case you answered “yes”: Do you have a positive impression of the organisation’s work?

Questions 4 and 5 to both roles were only asked after treatment *SOC*. Participants could mark “yes” or “no” and give further commentaries.

Chapter 3

Screening of Workers' Motivation under Endogenous Qualification

Although the relevance of work motivation for a worker's behavior is acknowledged in psychology, there are few economic models on work motivation. Like other-regarding preferences or inequality aversion, work motivation is viewed as a behavioral phenomenon that has only limited relevance for the big picture. What differentiates motivation from other factors is its direct influence on a worker's disutility of effort. That means, in contrast to outside-options or reference wages, taking motivation into account does not only result in a redistribution of rents but production possibilities are amplified. As a motivated worker performs better, firms' profits are higher than with unmotivated workers.

Job advertisements for university graduates announce selection procedures like assessment centers. This indicates that employers know that there is more than certifiable qualification that influences a worker's effort. That for some disciplines final grades only vary a little and thus there is room for additional differences between students, states a study from 2007 by the German Council of Science and Humanities (Wissenschaftsrat, 2007). In the natural sciences and also in Law and Sociology about 50% of graduates have the same grade. In Figure 3.1 the percentages of the different grades are given. In Sociology 60% of German graduates passed with "good", in Physics and Biology about the same percentage made "very good", whereas 40% of Law students passed their exams with "satisfactory" and another 40% with "fair".

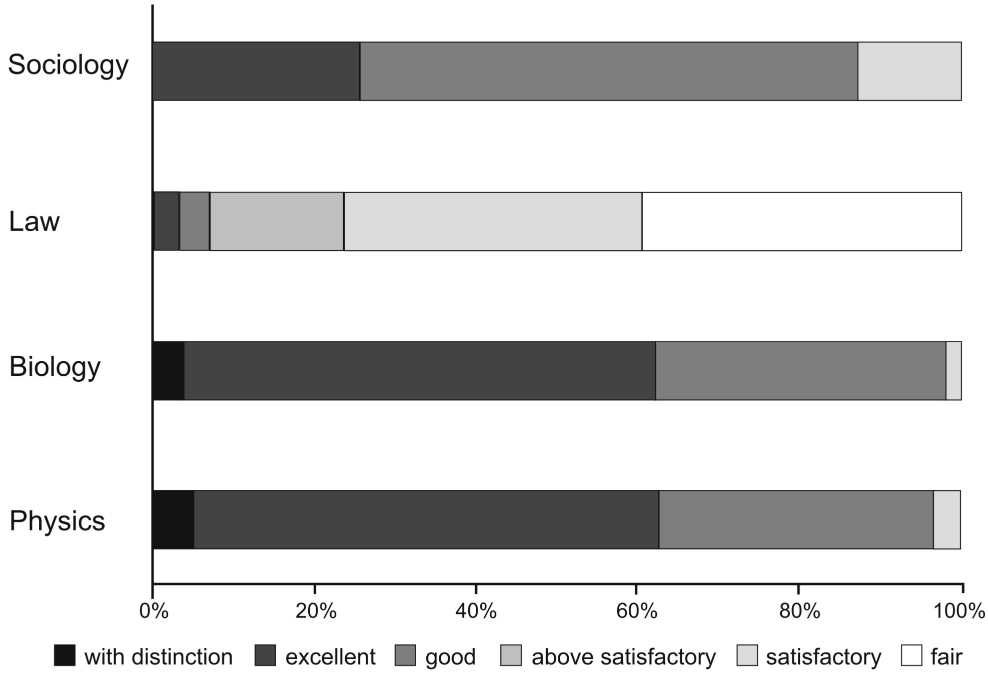


Figure 3.1: Grades of University Degrees in 2005 in Germany[1]

If only qualification was relevant, and we assume that certificates are a good approximation, why should employers invest into selection mechanisms? They invest, because there are other characteristics of job candidates, besides qualification, that are relevant. But even selection events cannot reveal a workers' work motivation for a certain job, thus, there needs to be found another mechanism to give both contractual parties the opportunity to profit from it.

Both, motivation as well as qualification, determine the workers' productivity, says Pinder (1984). Hence, employers need mechanisms for selection, that also account for motivational differences. Pinder (1997) describes a coherence between mental ability and work motivation and that both factors have a major influence on a worker's performance[2]. For example, higher intrinsic motivation could lead to higher productivity. An agent who likes his job achieves new knowledge easier. Motivation can even be a precondition for qualification. High-skilled

[1]Own diagram from data taken from the study of the German Council of Science and Humanities.

[2]p. 20–22.

workers normally do more challenging jobs, indicating a positive correlation between skills and intrinsic motivation. If skills are not seen as innate but stem back to education, high-skilled people once decided to invest in training in their field because they were/are interested in it. This could be another influencing factor on intrinsic motivation at work. On the other hand, for some high-skilled people, tasks might be too easy such that they get bored and accordingly have a lower intrinsic motivation. As there is contradicting evidence on this interdependence[3], we abstract from it in theory.

In our model, workers are different with respect to qualification and work motivation. As qualification is more or less observable through certificates, we assume certainty about qualification but asymmetric information on motivation: Motivation cannot be certified like a qualification outcome as it is specific to the situation. From this it follows that a prospective employer does not know the worker's level of motivation at the signing of a contract. References from earlier employers are also unable to reflect the whole picture.

Before turning to the theoretical model (Chapter 3.2) the economic literature on work motivation will be reviewed.

3.1 Literature on Intrinsic Motivation

There are some publications that treat intrinsic motivation in an economic model. Some change the agent's utility function, others solve a matching problem, where the agent profits from working for a principal with the same ideological aims. In both cases the agent draws utility not only from monetary income but also from the task itself or some characteristics of it.

Bénabou and Tirole (2003) analyze a framework with one principal and one agent. The principal knows more about the task than the agent does and hence, she knows better about the agent's prospective cost of exerting effort. The agent is offered a reward from the principal, if effort leads to success. This does not only depend on the agent's behavior but is also influenced by a draw of nature. The higher the proposed reward, the higher the agent expects the cost of his own

[3] Pinder (1997), p.21.

effort to be and the less likely he will accept the offered contract. This model reflects the findings on motivation crowding-out of e.g. Deci and Ryan (1980) and Frey (1997a): Workers' willingness to accept falls with high wages. Kreps (1997) also supports the crowding-out theory. He describes individual behavior as kind of reversed revealed preferences: Individuals try to rationalize their behavior. If they work without reward, they do it because of intrinsic motivation. But if they are paid for the same task, they will attribute their effort to the extrinsic reward and therefore feel less intrinsically motivated which will lead to a "distaste" for the job.

Grepperud and Pedersen (2006) look at the crowding-out effects on intrinsic motivation under performance pay and find a way to select agents with intrinsic motivation from others: In a moral hazard model observable output depends on effort and a random state of nature. Now the agent's utility from a contract also depends on the degree of performance pay. That means, varying performance pay has a crowding-out effect on intrinsic motivation. In a situation with crowding-out the authors find that the first-best situation cannot be reached, as the agent's effort falls under performance pay. This effect is stronger, the higher intrinsic motivation. The optimal contract offer to an intrinsically motivated agent does not include performance pay. Consequently, selection with regard to intrinsic motivation results, when contracts with and without performance pay are offered to a group of unequally motivated agents.

Besley and Ghatak (2005) describe a moral hazard model with three types of agents and principals. One type of each role is just profit-oriented the others are in addition interested in the mission of the business. Best match-quality is reached when a principal-agent-pair sticks to one common mission. The optimal contract contains a reservation wage and a bonus for the agent, with the bonus increasing in the degree of the agent's concession to the mission, that means to compensate the agent for giving up his ideal, the principal pays a bonus. If the principal has the possibility to choose the mission after employing the agent, she trades off between following her own mission and reducing the bonus payment. In contrast to the models by Bénabou and Tirole (2003) or Grepperud and Pedersen (2006), motivation depends on the organization the agent is employed at, which is a kind of task-contingency, and there is no crowding-out effect by assumption.

Also in Murdock (2002) agents have an intrinsic return from exerting certain projects, but he changes the agent's utility function and introduces intrinsic motivation as linearly depending from effort. Agents have a higher utility when they follow their preferred projects. Following that firms also follow negative-profit projects: To reward an intrinsically motivated agent for doing profitable projects, he is allowed to also follow projects with a negative profit but a positive surplus, which is the sum of the project's financial profit to the firm and the agent's intrinsic return. Murdock finds that implicit contracting is a complement of intrinsic motivation.

James Jr. (2005) introduces a utlity function with extrinsic motivation (incentive pay) and intrinsic motivation as a function of effort. At the first stage the principal offers a contract that the agent rejects or accepts, followed by choosing effort at the next stage. Depending on the wage scheme, the agent will be better off if he is not intrinsically motivated. Similar to Grepperud and Pedersen (2006), an intrinsically motivated agent profits from a lump sum wage while an extrinsically motivated agent prefers performance pay. James Jr. concludes, that the assumed combination of parameters in combination with incentive pay crowds out intrinsic motivation.

The richest framework on work motivation is given by Bewley (1999). In addition to conscious utility that depends on income and costs, he introduces unconscious utility, which also takes into account the "mood" of a worker and all possible kinds of non-extrinsic remuneration, like a nice working atmosphere and also joy caused by work itself. Therefore "mood" is intrinsic motivation. He finds that better mood can result in higher effort. Work moral consists in his definition of mood and internalization of the firm's objectives. Hence with mood also firm profits increase, as profits are part of a worker's utility, when his moral obligation is high. The richness of this model offers opportunities to test psychological findings, but does not give a hint on how to select the motivated from the less motivated candidates.

The closest related economic publication on intrinsic motivation of agents is Delfgaauw and Dur (2007). In contrast to the works already mentioned, agents' intrinsic motivation is unknown to the principal and his utility from it is concave in effort. The principal posts a job opening with a credible minimum wage. Then agents decide to apply/not apply at a certain cost and the principal learns the motivational type of the applicants. The principal offers a wage to one of them and the agent accepts or rejects. The offered wage has to be at least as high as the announced minimum wage. At the first stage the principal wants to sort with regard to motivation and sets a binding minimum wage. As there is a tradeoff between keeping agents with low motivation from applying (setting a low minimum wage) and risking a high proportion of low motivated agents applying (setting a high minimum wage), the choice of the optimal minimum wage is not straightforward. At first glance a high minimum wage seems preferable, as motivation becomes observable after application, but as the minimum wage offer is binding, the principal risks a higher than optimal wage to a low motivated agent, if no better types apply. Hence the optimal minimum wage is set to compensate the least motivated type, the principal wants to accept and meets his outside option. All agents with lower motivation do not apply and better types get a surplus over their cost of production and application.

These authors (Delfgaauw & Dur, 2008) also describe a situation in public institutions with three types of agents. Lazy, normal and public service motivated agents. Normal and lazy workers' effort cost do not differ between private firms and public service. Lazy workers, have highest cost of effort, no matter what occupation. Motivated workers have lower effort costs than normal workers only in public service occupations. If effort is observable but not the types, there is a selction problem between motivated agents and the other types for public institutions. The state provides a public good that is produced with a certain level of effort and chooses how many workers and which type of worker it employs. Of course public service motivated agents would be preferred, as their effort costs are lowest. If there are not enough motivated agents in the population, Delfgaauw and Dur (2008) assume that the state now chooses between offering self-selecting contracts to motivated and normal, or to motivated and lazy workers. As a lazy worker has the lowest outside option, a screening contract between motivated and lazy workers incurs the lowest information rent to the motivated agent. Hence, the state chooses to employ public service motivated and lazy workers as a second best strategy, if the agents' types are unobservable. In contrast to the thesis at hand, workers on the one hand do not by themselves decide about their productivity type, which for unmotivated can be lazy or normal, thus there is no coordination problem between them. On the other hand, workers can work at an alternative occupation, which is a firm in the private sector. This simplifies the analysis because some separating contracts are not offered as they lead to a non-positive gain to the firm in the public sector. In addition they assume the second order conditions of the public sector's selection problem to be fulfilled. Here, it will be shown that this assumption is not always justifiable and thus their analysis misses part of the solution.

A similar selection problem solve Handy and Katz (1998): In explaining the wage differential of managers between for- and non-profit firms, they look at a selection problem between high ability managers who are either devoted to the non-profit's aims or indifferent. The third type of managers is of low ability. All characteristics of managers are given by nature. The skill-level is represented by the predetermined output that a certain type produces: Highly skilled produce more than low skilled and for non-profit firms highly skilled and devoted produce more than their indifferent peers and these more than low skilled managers. Managers also differ regarding their reservation wages. Highly skilled have higher reservation wages than low skilled and for jobs at non-profit firms devoted managers' reservation wage lies in between. Firms offer a wage and choose at random an applicant to test him for his ability. Although the result is noisy, he will be employed, if he is highly skilled, if not, another candidate will be randomly selected until a high-ability manager is found. Thus for for-profit firms there is only a little uncertainty about a manager's type. Non-profit firms want to offer a wage that selects devoted managers from the high ability ones. As their reservation wage is lower than that of high ability and indifferent managers, non-profit firms try to choose wages that lead to a self selection of devoted managers. In result, managers at non-profit firms get a lower financial payoff than their peers in for-profit firms. This kind of self-sorting also increases the surplus of the firm.

3.2 Modeling Work Motivation

One of the basic economic assumptions is that all households are utility maximizers. A worker's standard utility function depends positively on income and negatively on work effort. So if he works more than he is compensated for, his behavior is either not utility maximizing or the assumed utility function is misspecified. If we want to keep the rationality assumption for intrinsically motivated workers, we need to redefine the utility function. It shall explain the exerted effort as the optimal answer to the prevailing contract, such that the agent's behavior is not suboptimal any more. Thus, we introduce positive utility that is drawn from work because of intrinsic motivation. This positive effect cannot be linear because a feeling of work overload and routine decreases marginal utility from work for higher effort levels, as the "principle of effort-calculation"[4] by Meyer (1973) and Kukla (1972) states[5]. When describing intrinsic motivation, we follow the theoretical model by Delfgaauw and Dur (2007).

As argued in the previous chapter, there are no clear signals for the intrinsic motivation of an agent. Motivation cannot be certified, which leads to an information asymmetry between employee and employer; especially because motivation is depending on the task. A recent study financed by the German Federal Ministry of Labor and Social Affairs[6] found that there is a significant correlation between firm profits and worker engagement ($R^2 = 0.31$; Hauser, Schubert, and Aicher (2008)). Therefore, employers want to employ motivated workers to benefit from their motivation by paying less than they have to pay to an unmotivated agent for the same job.

We want to combine these results to set up a theoretical model of intrinsically motivated agents with endogenous qualification. Qualification can be proven by certificates while only the distribution of motivated agents in the population is known to principals[7]. As these prefer motivated agents, they try to overcome this information asymmetry by offering a selecting menu of contracts.

[4] "Anstrengungskalkulationsprinzip", translation by author.

[5] Cited following Rheinberg (2006).

[6] Bundesministerium für Arbeit und Soziales

[7] This assumption can be justified by employers' experience with other employees or from published surveys like those of Bewley (1995).

3.2.1 Intrinsic Motivation under Heterogenous Qualification

Every agent (worker) has an innate motivation for the only available job in this world. He has certainty about his motivational return regarding the job. In the utility function of a motivated agent, we introduce an element that is increasing and concave in output, that means disutility due to effort is partly offset by the worker's satisfaction: He likes his job and therefore enjoys work. With increasing effort, the marginal rate of the worker's satisfaction or intrinsic motivation decreases. This reflects the possibility of being over-worked.

Cost of production is assumed to depend on the agent's qualification: The higher skilled an agent is, the lower are his cost of producing one unit of output. From a certain output level, intrinsic motivation is overcompensated by production cost and utility falls with increasing output. There are two possible levels of qualification namely high- and low-skilled. In the beginning, all agents are low-skilled, but they can become high-skilled by deciding in favor of taking part in costly training. Training costs depend on the agents' wage. These training costs come as an educational loan, which means: every agent has to pay a percentage of his wage after deciding in favor of a certain contract. Thus, he can evade qualification costs if he does not accept a contract and the principal has to take into account the agent's qualification cost, when she offers a contract to a high-skilled agent as these are not sunk.

This kind of educational loan is comparable to the German "Bundesausbildungsförderungsgesetz": Students get a loan from the state and have to repay it in monthly rates that depend on their income after graduating.[8] Education costs in this model, can therefore be seen as the first period repayment without depreciation.

Every principal is able to hire one agent. Principals and agents are matched randomly one by one. There is only one match, i.e. if no contract is fixed between a pair, there will not be a second chance for hiring/being hired for either side. Although the agent bears the cost of production, the principal is interested in knowing the agent's type. A high-skilled produces the same quantity at a lower

[8] They only have to pay back half of it.

wage than a low-skilled agent. The relation between an agent's motivation and the principal's profit works the same way. The more motivated an agent is at doing his job, the less the principal has to pay to compensate the agent for production costs. As motivation cannot be measured, there is no possibility to verify motivation ex ante. After taking part in training, workers can be identified as high- or low-skilled. A principal only knows the distribution of motivation in both skill groups, and hence tries to write contracts, combining a lump sum transfer and a production quantity, to offer contracts that suit the different motivational levels of the workers in "her" agent's skill group. A lump-sum transfer is especially suitable for motivated agents as any crowding effects on intrinsic motivation (crowding-out and crowding-in) can be avoided. If workers are paid depending on their performance, for example with a piece rate, this effect needs to be taken into account.

3.2.2 Screening of Motivation with a Continuum of Types

Differences in workers' motivation can be very small such that motivation can be described by a continuous function, which we do in this section[9]. At the same time this constitutes the most general case. Later on we will refine the problem by assuming a two-point distribution of motivation with motivated and unmotivated agents.

3.2.2.1 Agents

With $q \geq 0$ as the production quantity and $w \in \mathbb{R}$ as the transfer from a principal to an agent being contractible and enforceable, there is no incentive problem after the contract is concluded. The agent's utility $u(w, q)$ is a standard function amplified by $\eta(q) = \eta \cdot q^{\alpha}$, with $\eta > 0$ and $\alpha \in [0, 1]$. It is a concave and increasing function[10] in the production quantity q and zero for $q = 0$. As argued in Section 3.2.1, motivation increases with the quantity produced to a decreasing degree. The additional influence in the utility function reflects an agent's motivational utility from working. The agent's utility can be measured

[9] A game-theoretical description of this model is given in the Appendix (3.3.1).
[10] This terminus follows Delfgaauw and Dur (2007).

in monetary units.

$$u(w,q) = w - \theta q + \eta \cdot q^{\alpha}$$

The agent's qualification or skill level is $\theta \in \{\underline{\theta}, \overline{\theta}\}$. A high skill level results from education, which is costly to the agent. When he decides to invest into his skills, he has to bear costs $\hat{\kappa} \cdot w$ ($\kappa \in]0,1[$). That means, only $\kappa \cdot w$ with $\kappa = 1 - \hat{\kappa}$ is left to him. His cost of producing one unit[11] decreases from $\overline{\theta}$ to $\underline{\theta}$, with $\underline{\theta} < \overline{\theta}$. The level of qualification is assumed to be known to both, principal and agent, as it is certifiable.

The variables influenced by the motivational type of an agent are $w = w(\eta)$ and $q = q(\eta)$, because the menu of contracts offered to the agent will depend on the distribution of motivational types. Motivation η is assumed to be distributed within $[\underline{\eta}, \overline{\eta}]$ with a density $f(\eta)$ and the distribution function $F(\eta)$. If we put this information into the agent's utility function, it becomes:

$$u[w(\eta), q(\eta)] = w(\eta) - \theta q(\eta) + \eta \cdot [q(\eta)]^{\alpha}$$

If the agent does not work, his outside option is zero. In other words, there are no subsidies and there is no possibility to work at another place. This assumption is qualitatively not restrictive, as is laid out in Appendix 3.3.2.

3.2.2.2 The Principal

The principal's profit depends on the amount of output that is produced and on the transfer she has to pay to the agent:

$$E[\Pi[w(\eta), q(\eta)]] = \int_{\underline{\eta}}^{\overline{\eta}} [\varphi[q(\eta)]^{\alpha} - w(\eta)] \cdot f(\eta) d\eta$$

with $\varphi > \eta > 0$ and thus the principals profit $\varphi[q(\eta)]^{\alpha}$ is increasing and concave in q and zero for $q = 0$. φ is assumed to be larger than η as otherwise the employer could sell the shop to the worker. The principal is assumed not to take

[11] θ refers to production cost. Hence, a high (skill) type has lower costs ($\underline{\theta}$) than a low (skill) type ($\overline{\theta}$).

the agent's observable qualification as a signal for his motivational type but to take the initial distribution $F(\eta)$ as given for both skill-levels. As the principal offers a set of contracts to the agent, she can decide about q and w. The principal wants to profit from higher motivated agents' lower wage needs and thus writes incentive compatible contracts in the sense that agents choose the contract that suits their motivational type.

As in later steps of analysis more general functions for the principal's gain and agent's motivational utility become intractible, we decided in favour of solvability, accepting a small loss in generality.

3.2.2.3 Sequence of Decisions

Principals and agents do not decide simultaneously, hence we give an overview to the sequence of decisions in Figure 3.2.

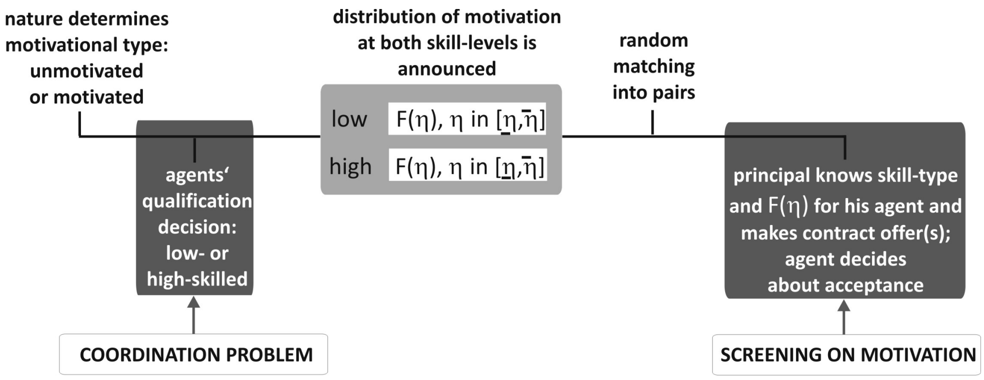


Figure 3.2: Sequence of Moves for Continuously Distributed Motivational Types

We work backward through the decisions to receive an incentive compatible menu of contracts for each skill-level and the equilibrium qualification decision of an agent. Under the assumption of observable skill types, the principal only needs to separate between motivational types of given qualification. We will do the analysis for high-skilled agents with skill-parameter $\underline{\theta}$ and $\kappa \cdot w$ as the remainder of the wage after paying qualification cost. For low-skilled agents at the end $\underline{\theta}$ will be replaced by $\overline{\theta}$ and $\kappa = 1$ as they can keep the whole wage.

3.2.2.3.1 The Principal's Contract Offer As agents accept the utility maximizing contract with respect to their motivational type, the principal maximizes her expected gain under the agents' participation constraints and incentive compatibility for all motivational types. To high-skilled agents the principal offers a menu of contracts $\{\underline{w}(\eta), \underline{q}(\eta)\}$ resulting from:

$$\max_{\{w(\eta), q(\eta)\}} E[\Pi[w(\eta), q(\eta)]]$$

subject to

$$\begin{aligned} u[w(\eta), q(\eta)] = \kappa w(\eta) - \underline{\theta} q(\eta) + \eta \cdot [q(\eta)]^\alpha &\geq 0 \\ \kappa w(\eta) - \underline{\theta} q(\eta) + \eta \cdot [q(\eta)]^\alpha &\geq \kappa w(\hat{\eta}) - \underline{\theta} q(\hat{\eta}) + \eta \cdot [q(\hat{\eta})]^\alpha \\ \forall \eta, \hat{\eta} \in [\underline{\eta}, \overline{\eta}], \, \eta \neq \hat{\eta} & \end{aligned}$$

The side conditions are the agents' participation and incentive compatibility constraints[12]. The participation constraint will be fulfilled for all types if it is fulfilled for the least motivated agent ($\underline{\eta}$) and if the incentive compatibility constraints are fulfilled, too. If all types are better off with their own, than with a lower motivated type's contract and the least motivated agent's participation constraint is fulfilled, their utility must exceed their outside-option and thus all participation constraints are fulfilled. They can be reduced to the least motivated type's constraint:

$$\kappa w(\underline{\eta}) - \underline{\theta} q(\underline{\eta}) + \underline{\eta} \cdot [q(\underline{\eta})]^\alpha \geq 0$$

The incentive compatibility constraints can be simplified by looking at the acceptance behavior of the agents. Knowing, that an agent will accept the contract, that gives him maximal utility given his own type η, the principal chooses $\{w(\eta); q(\eta)\}$ such that the agent reveals by his contract choice his real motivational type. This is equal to an agent maximizing

$$\max_{\hat{\eta}} \kappa w(\hat{\eta}) - \underline{\theta} q(\hat{\eta}) + \eta \cdot [q(\hat{\eta})]^\alpha .$$

[12] Bolton and Dewatripont (2005) solve a similar problem for sellers and buyers, with buyers differing in their valuation for the offered good.

The agent chooses a contract, that depends on a certain level of motivation $\hat{\eta}$. He cannot choose his own motivation η as it is given by nature. The first order condition of this problem results from derivation with respect to $\hat{\eta}$:

$$\kappa w'(\hat{\eta}) - \underline{\theta} q'(\hat{\eta}) + \eta \cdot \alpha [q(\hat{\eta})]^{\alpha-1} q'(\hat{\eta}) = 0$$

This equation gives an incentive compatible contract, whenever $\hat{\eta} = \eta$, which is, the agent chooses "his" contract and such reveals his motivational type:

$$\kappa w'(\eta) - \underline{\theta} q'(\eta) + \eta \cdot \alpha [q'(\eta)]^{\alpha-1} q'(\eta) = 0 \tag{3.1}$$

For (3.1) to constitute the maximum of the agents' utility, the second order condition must be negative at $\eta = \hat{\eta}$:

$$\kappa w''(\hat{\eta}) - \underline{\theta} q''(\hat{\eta}) + \eta\alpha(\alpha - 1)[q(\hat{\eta})]^{\alpha-2} q'(\hat{\eta}) + \eta\alpha[q(\hat{\eta})]^{\alpha-1} q''(\hat{\eta}) \overset{!}{<} 0 \tag{3.2}$$

As (3.1) has to hold for all $\eta \in [\underline{\eta}, \overline{\eta}]$, it may not change for changing η, i.e. its derivative, with respect to η is zero:

$$\underbrace{\kappa w''(\eta) - \underline{\theta} q''(\eta) + \eta\alpha(\alpha - 1)[q(\eta)]^{\alpha-2} q'(\eta) + \eta\alpha[q(\eta)]^{\alpha-1} q''(\eta)}_{\text{LHS of (3.2)}} + \alpha[q(\eta)]^{\alpha-1} \cdot \frac{dq(\eta)}{d\eta} = 0$$

The negativity condition (3.2) is satisfied for $\frac{dq(\eta)}{d\eta} \geq 0$ (monotonicity). From this, the simplified maximization programme for the principal can be stated as:

$$\max_{\{w(\eta), q(\eta)\}} \quad E[\Pi[w(\eta), q(\eta)]]$$

subject to

$$\begin{aligned}
\kappa w(\underline{\eta}) - \underline{\theta} q(\underline{\eta}) + \underline{\eta} \cdot [q(\underline{\eta})]^{\alpha} &\geq 0 \\
\underline{\theta} q'(\eta) - \eta\alpha[q(\eta)]^{\alpha-1} q'(\eta) &= \kappa w'(\eta) \\
\frac{dq(\eta)}{d\eta} &\geq 0
\end{aligned}$$

This maximization problem is solved without the monotonicity condition, following the now standard procedure introduced by Mirrlees (1971), then the result is checked for fulfilling the condition:

$$\begin{aligned} u(\eta) &\equiv \kappa w(\eta) - \underline{\theta} q(\eta) + \eta \cdot [q(\eta)]^{\alpha} \\ &= \max_{\hat{\eta}} \; \{\kappa w(\hat{\eta}) - \underline{\theta} q(\hat{\eta}) + \eta \cdot [q(\hat{\eta})]^{\alpha}\} \end{aligned} \tag{3.3}$$

Making use of the envelope theorem to $u(\eta)$ and expressing $u(\eta)$ as an integral we get a tractable function of η, so that $w(\eta)$ can be replaced in the principal's yield function[13]:

$$\begin{aligned} \frac{\partial u(\eta)}{\partial \eta} &= [q(\eta)]^{\alpha} \\ u(\eta) &= \int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx + u(\underline{\eta}) \\ &= \int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx \end{aligned}$$

The transfer from the principal to the agent can be replaced by

$$w(\eta) = \frac{1}{\kappa} \int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx + \underline{\theta} q(\eta) - \eta [q(\eta)]^{\alpha} \tag{3.4}$$

and the principal's yield function becomes:

$$E[\Pi[q(\eta)]] = \int_{\underline{\eta}}^{\overline{\eta}} \left[(\varphi + \frac{\eta}{\kappa}) \cdot [q(\eta)]^{\alpha} - \frac{\underline{\theta}}{\kappa} \cdot q(\eta) - \frac{1}{\kappa} \int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx \right] f(\eta) d\eta$$

[13] $u(\underline{\eta}) = 0$ as the participation constraint of the lowest motivational type is binding at the optimum.

which can be simplified by partial integration to[14]:

$$E[\Pi[q(\eta)]] = \int_{\underline{\eta}}^{\overline{\eta}} \left[(\varphi + \frac{\eta}{\kappa}) \cdot [q(\eta)]^{\alpha} - \frac{\theta}{\kappa} q(\eta) - \frac{1}{\kappa h(\eta)} \cdot [q(\eta)]^{\alpha} \right] f(\eta) d\eta \qquad (3.5)$$

Where $(\varphi + \frac{\eta}{\kappa}) \cdot [q(\eta)]^{\alpha} - \frac{\theta}{\kappa} q(\eta)]^{\alpha}$ is the first-best social surplus, $\frac{1}{\kappa h(\eta)} \cdot [q(\eta)]^{\alpha}$ is the impact of the incentive problem on the social surplus, and $h(\eta) = \frac{f(\eta)}{1-F(\eta)}$ is the hazard rate. To maximize $E[\Pi[q(\eta)]]$ over q, we can maximize the integrand of (3.5) by making use of the *fundamental theorem of calculus* (see e.g. Kaplan (2003), p. 216). The condition for an optimal menu of contracts results and has to be checked for monotonicity:

$$\alpha \cdot [q(\eta)]^{\alpha-1} \left[(\varphi + \frac{\eta}{\kappa}) - \frac{1}{\kappa h(\eta)} \right] - \frac{\theta}{\kappa} = 0 \qquad (3.6)$$

The change of q in η is monotonic, if the implicit differential of (3.6) is not negative.

$$\left. \frac{dq(\eta)}{d\eta} \right|_{q = q^*} = \frac{\alpha [q(\eta)]^{\alpha-1} \left(1 - \frac{h'(\eta)}{[h(\eta)]^2} \right) \frac{1}{\kappa}}{\alpha(1-\alpha)[q(\eta)]^{\alpha-2}} \qquad (3.7)$$

14

$$\begin{aligned}
\int_{\underline{\eta}}^{\overline{\eta}} \int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx \cdot f(\eta) d\eta &= \left[\int_{\underline{\eta}}^{\eta} [q(x)]^{\alpha} dx \cdot F(\eta) \right]_{\underline{\eta}}^{\overline{\eta}} - \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} \cdot F(\eta) d\eta \\
&= \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} d\eta \cdot F(\overline{\eta}) - \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} d\eta \cdot F(\underline{\eta}) - \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} F(\eta) d\eta \\
&= \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} d\eta - \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} F(\eta) d\eta \\
&= \int_{\underline{\eta}}^{\overline{\eta}} [q(\eta)]^{\alpha} [1 - F(\eta)] d\eta.
\end{aligned}$$

If motivation η is for example uniformly distributed, with

$$f(\eta) = f_U(\eta) = \begin{cases} \frac{1}{\overline{\eta}-\underline{\eta}} & \forall\, \eta \in [\underline{\eta}, \overline{\eta}] \\ 0 & \text{else} \end{cases}$$

(3.7) becomes zero as the derivative of the inverse hazard rate $\left(\frac{h'(\eta)}{[h(\eta)]^2}\right)$ is unity. The hazard rate is nondecreasing for the uniform, as well as for the normal and the exponential distribution, and thus the monotonicity condition is fulfilled for the most common distribution assumptions (see e.g. Bolton and Dewatripont (2005), p.88).

Result 1: *For continuous motivation the optimal menu of contracts* $\{\underline{w}(\eta), \underline{q}(\eta)\}$ *to a high-skilled agent is defined by:*

$$\underline{q}^*(\eta) = \left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{1}{1-\alpha}} \left(\varphi + \frac{\eta}{\kappa} - \frac{1}{\kappa h(\eta)}\right)^{\frac{1}{1-\alpha}}$$

and

$$\underline{w}^*(\eta) = \frac{1}{\kappa}\int_{\underline{\eta}}^{\eta} [q(x)]^\alpha dx + \frac{\theta}{\kappa} q(\eta) - \frac{\eta}{\kappa}[q(\eta)]^\alpha.$$

Agents reveal their motivational type by choosing the suitable contract. For low-skilled agents $\underline{\theta}$ *has to be replaced by* $\overline{\theta}$ *and* $\kappa = 1$, *which yields:*

$$\overline{q}^*(\eta) = \left(\frac{\alpha}{\overline{\theta}}\right)^{\frac{1}{1-\alpha}} \left(\varphi + \eta - \frac{1}{h(\eta)}\right)^{\frac{1}{1-\alpha}}$$

and

$$\overline{w}^*(\eta) = \int_{\underline{\eta}}^{\eta} [q(x)]^\alpha dx + \overline{\theta} q(\eta) - \eta[q(\eta)]^\alpha.$$

Where we took the optimal wages from (3.4). The corresponding utilities for high- and low-skilled agents are

$$\underline{u}^*(\eta) = \int_{\underline{\eta}}^{\eta} [\underline{q}(x)]^\alpha dx \text{ and } \overline{u}^*(\eta) = \int_{\underline{\eta}}^{\eta} [\overline{q}(x)]^\alpha dx.$$

As for the least motivated agents ($\underline{\eta}$) the lower and upper boundary of the integral coincide, these have zero utility from such a contract. The principal's expected profit from offering the suitable incentive compatible menu of contracts regarding the agent's skill-level is

$$E[\Pi(\underline{w}(\eta), \underline{q}(\eta))] = \frac{(1-\alpha)\underline{\theta}}{\alpha\kappa} \int_{\underline{\eta}}^{\overline{\eta}} [\underline{q}^*(\eta)] f(\eta) d\eta$$

for contracting with a high-skilled and

$$E[\Pi(\overline{w}(\eta), \overline{q}(\eta))] = \frac{(1-\alpha)\overline{\theta}}{\alpha} \int_{\underline{\eta}}^{\overline{\eta}} [\overline{q}^*(\eta)] f(\eta) d\eta$$

for contract offers to a low-skilled agent.

3.2.2.4 The Agents' Qualification Decision

Now the agents' qualification decisions as the first decision of the model are looked at. Training costs are a tax on the wage w of $\hat{\kappa} = 1 - \kappa$. As they are paid by the agent at the time he concludes a contract, the principal takes these into account in the constraints to her maximization problem. Hence the high-skilled agents' utility is already net of qualification cost, which are not sunk. The principal is assumed not to try to derive the actual distribution of motivation, which results from the agents' qualification decisions. To her the initial distribution of motivation applies for both skill-levels.[15] Taking this behavior of principals into account, the equilibrium qualification decision depends on the combination of qualification cost and the skill-parameters. If we compare an agent's difference

[15] Compare the Appendix 3.3.1.

in utilities of the two skill-levels, he is indifferent between becoming high-skilled and remaining low-skilled for:

$$\begin{aligned}
\underline{u}^*(\eta) &= \overline{u}^*(\eta) \\
\int_{\underline{\eta}}^{\eta} \left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi + \frac{x}{\kappa} - \frac{1}{\kappa h(x)}\right)\right]^{\frac{\alpha}{1-\alpha}} dx &= \int_{\underline{\eta}}^{\eta} \left[\frac{\alpha}{\overline{\theta}}\left(\varphi + x - \frac{1}{h(x)}\right)\right]^{\frac{\alpha}{1-\alpha}} dx \\
\overline{\theta}^{\frac{\alpha}{1-\alpha}} \int_{\underline{\eta}}^{\eta} \left(\kappa\varphi + x - \frac{1}{h(x)}\right)^{\frac{\alpha}{1-\alpha}} dx &= \underline{\theta}^{\frac{\alpha}{1-\alpha}} \int_{\underline{\eta}}^{\eta} \left(\varphi + x - \frac{1}{h(x)}\right)^{\frac{\alpha}{1-\alpha}} dx
\end{aligned}$$

The value of the integral is larger for being low-skilled than for being high-skilled and as $\overline{\theta} > \underline{\theta}$, both sides can be equal in size. Hence, there may be combinations of κ, $\underline{\theta}$ and $\overline{\theta}$ that lead to an indifference between the two skill-levels, but they cannot be stated without further assumptions to the variables.

Result 2: *It depends on the combination of κ, $\underline{\theta}$ and $\overline{\theta}$ if qualification pays off to the agents or not.*

There are combinations of the exogenous variables that result in a positive compared utility from becoming high-skilled. In the following example we want to show that there exists a well behaved solution in the continuous case.

Numerical Example

The principal's gain from every unit produced is determined by $\Pi(q) = 25\sqrt{q}$. Agents motivation η is assumed to be uniformly distributed within $[0, 10]$ at both skill-levels and high (low) qualification leads to cost per unit produced of $\underline{\theta} = 1$ ($\overline{\theta} = 2$). The agents' motivational utility is $\eta\sqrt{q}$ and the qualification cost parameter is set at $\kappa = 0.8$ (i.e., the tax on the wage is $\hat{\kappa} = 0.2$). By plugging these values into the conditions for the second-best optimum, we get for a low-skilled agent:

$$\{\overline{q}(\eta)\ ;\ \overline{w}(\eta)\} = \left\{(3.75 + 0.5\eta)^2\ ;\ 14.0625 + (3.75 + 0.5\eta)^2\right\},$$

and for a high-skilled agent:

$$\left\{\underline{q}(\eta)\ ;\ \underline{w}(\eta)\right\} = \left\{(5+0.5\eta)^2\ ;\ 31.25+6.25\eta\right\}.$$

The agents' utility is determined by: $\overline{u}(\eta) = 3.75\eta + 0.25\eta^2$ for low-skilled and $\underline{u}(\eta) = 5\eta + 0.25\eta^2$ for high-skilled agents. Thus, all agents at least weakly prefer becoming high-skilled as the difference in utilities is not negative.

With motivational screening, a principal's expected profit is $E[\overline{\Pi}(\eta)] = 125$ if he employs a low-skilled agent and $E[\underline{\Pi}(\eta)] = 93.75$ if he employs a high-skilled agent. That the expected profit from contracting with a low-skilled agent is higher than from a contract with his high-skilled peer, results from the fact that in this example, with a low-skilled, intrinsic motivation has a higher impact on profit than with a high-skilled agent. The base-profit from contracting with a high-skilled type is higher than with a low-skilled agent. Keep in mind, that the principal is able to identify "his" agent's skill-level, but he may not choose between contracting with high- or low-skilled types.

In the next section the case of a two-point-distribution of motivation and principals knowing the actual distributions of motivation for the two skill-types is described, to see additional characteristics of selection on innate characterisitcs under endogenous and observable qualification.

3.2.3 Screening with Motivated and Unmotivated Agents

In the following we analyze a situation with only two levels of motivation: motivated and unmotivated. An agent's utility is the same as in the case with continuously distributed types but the motivational parameter η is a given parameter and either 0 for unmotivated agents or positive for motivated agents. Again, agents decide first about their productivity enhancing investment into qualification[16]. An agent's utility is:

[16] The game-theoretic setup of this model can be found in the Appendix (3.3.1).

$$u(q, w) = \kappa w - \theta q + \eta q^{\alpha} \tag{3.8}$$

Again, $\theta \in \{\underline{\theta}, \overline{\theta}\}$ reflects qualification. A high-skilled agent has invested into qualification at cost $\hat{\kappa} w = (1-\kappa) w$ ($\kappa \in]0,1[$ and $\kappa = 1 - \hat{\kappa}$). When an agent decides to invest into his skills, his cost of producing one unit decreases from $\overline{\theta}$ to $\underline{\theta}$, with $\underline{\theta} < \overline{\theta}$. Thus, the parameter values of κ, θ and η depend on the respective agent's motivational type and the chosen skill-level. The following table gives an overview over their values:

Table 3.1: Paramter values of the four possible agent types ($\eta/\kappa/\theta$)

	unmotivated	motivated
low-skilled	$0/1/\overline{\theta}$	$\eta/1/\overline{\theta}$
high-skilled	$0/\kappa/\underline{\theta}$	$\eta/\kappa/\underline{\theta}$

If we insert those values into (3.8), the four possible types of agents have utilities of

1. high-skilled and motivated: $u^m = \kappa w - \underline{\theta} \cdot q + \eta \cdot q^{\alpha}$
2. low-skilled and motivated: $u^m = w - \overline{\theta} \cdot q + \eta \cdot q^{\alpha}$
3. high-skilled and unmotivated: $u^0 = \kappa w - \underline{\theta} \cdot q$
4. low-skilled and unmotivated: $u^0 = w - \overline{\theta} \cdot q$.

The principal's profit depends on the amount of output that is produced and on the transfer she has to pay to the agent:

$$\Pi(q, w) = \varphi \cdot q^{\alpha} - w$$

As the principal offers a set of contracts to the agent, she can decide about q and w. A motivated agent has lower production costs than his equally skilled peer. Knowing the agent's qualification, the principal is interested in telling the two remaining motivational types from each other and writes incentive compatible contracts in the sense that no type has an incentive to mimic another type. As qualification is common knowledge, the two separating menus of contracts divide the two motivational types each at one skill-level. It is assumed that in the case of indifference between two contracts, the "right" contract is accepted, that means the contract which enables the principal to a higher gain.

The sequence of moves is similar to that in the model with continuous motivational types and illustrated in Figure 3.3.

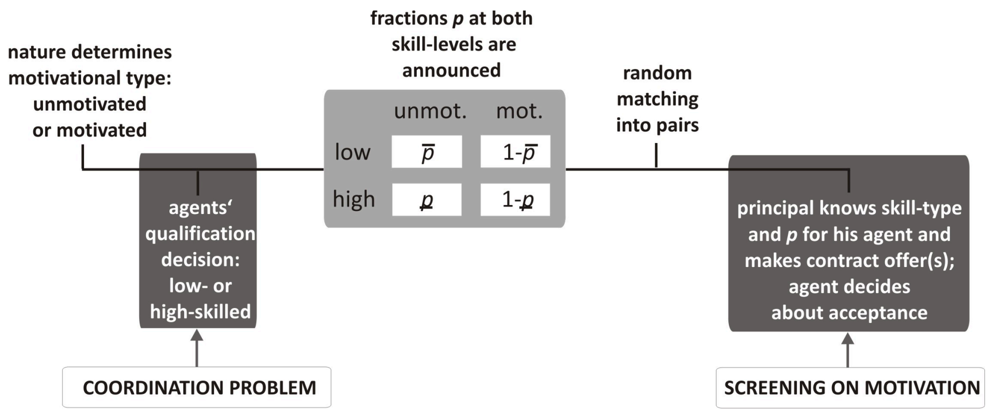


Figure 3.3: Sequence of Moves for Two Distinct Motivational Types

We solve this problem applying backward induction: At first the principal's selection problem is solved, which results in different utilities from contracts for the different types of agents. As we assume agents to be non-atomic, that is, their qualification decision has an influence on the fraction of unmotivated on the high ($\underline{p}$) and on the low ($\overline{p}$) skill-level also from the principal's view, the contractual utilities depend on all agents' qualification decisions. This leads to a coordination problem between the agents, which will be analyzed after the screening game.

In the next section, the optimal contract offer by the principal is derived for observable and unobservable motivation. The case with full information shall serve as a benchmark and will become useful in later steps of the analysis.

3.2.3.1 The Optimal Menu of Contracts

The principal's problem is similar for being matched with a high- or a low-skilled agent. Hence, we solve her maximization assuming high-skilled agents with $\kappa \in]0,1[$ and $\theta = \underline{\theta}$ and replace those values at the end by $\kappa = 1$ and $\theta = \overline{\theta}$ to have the solutions for the situation where the principal meets a low-skilled agent.

As the fraction p of unmotivated agents in a skill group can assume values from zero to one, we have to look at two different informational situations to the principal. If the skill group he faces consists of only one motivational type, which is $p \in \{0,1\}$, she has full information about the agent's characteristics and can offer the suitable first-best contract. When there are unmotivated and motivated agents, $p \in]0,1[$, she decides under incomplete information.

3.2.3.1.1 Full Information: First-Best Contracts In the most simple situation the principal knows the type of the agent she faces. All offered contracts are take-it-or-leave-it offers, so the principal has full bargaining power and agents accept every offer that meets at least their outside-option. There are neither alternative employment nor unemployment subsidies. Thus an agent's reservation utility is zero.

The principal maximizes her profit with respect to the participation constraint of the respective agent. In this case, there need no incentive constraints to be fulfilled as the principal only offers the suitable first-best contract instead of one contract for each type.

If there are only motivated agents under high-skilled agents ($\underline{p} = 0$), the principal maximizes her gain $\Pi(q,w)$ from contracting with a motivated agent:

$$\max_{\{(q,w)\}} \varphi(q)^{\alpha} - w$$

subject to

$$u = \kappa w - \underline{\theta} \cdot q + \eta q^{\alpha} \geq 0 \tag{3.9}$$

The principal makes use of her advantage over the agent and chooses w to fulfill the participation constraint with equality. By putting (3.9) into $\Pi(q, w)$ and maximizing with respect to q, we get the first order condition

$$\alpha\left(\varphi+\frac{\eta}{\kappa}\right)(\underline{q}_{FB}^{m*})^{\alpha-1}-\frac{\theta}{\kappa}=0.$$

By an analogous optimization we derive

$$\alpha\varphi(\underline{q}_{FB}^{0*})^{\alpha-1}-\frac{\theta}{\kappa}=0.$$

for a homogenously unmotivated skill group ($\underline{p}=1$). The second order conditions are always fulfilled. All agents have zero utility. Motivational utility $\eta\cdot(\underline{q}_{FB}^{m*})^{\alpha}$ is positive, for this reason a negative transfer is paid to the motivated agent.[17] The agent buys himself into a work relationship.

Result 3: *With homogenously motivated skill groups, the principal offers to unmotivated agents* ($p = 1$)*:*

$$\{w_{FB}^{0*}; q_{FB}^{0*}\} = \left\{\frac{\theta}{\kappa}\left(\frac{\alpha\kappa}{\theta}\varphi\right)^{\frac{1}{1-\alpha}}; \left(\frac{\alpha\kappa}{\theta}\varphi\right)^{\frac{1}{1-\alpha}}\right\}$$

and to motivated agents ($p = 0$)*:*

$$\{w_{FB}^{m*}; q_{FB}^{m*}\} =$$

$$\left\{\frac{\theta}{\kappa}\left[\frac{\alpha\kappa}{\theta}\left(\varphi+\frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}}-\frac{\eta}{\kappa}\left[\frac{\alpha\kappa}{\theta}\left(\varphi+\frac{\eta}{\kappa}\right)\right]^{\frac{\alpha}{1-\alpha}}; \left[\frac{\alpha\kappa}{\theta}\left(\varphi+\frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}}\right\}.$$

With $\kappa\in]0,1[$ *and* $\underline{\theta}$ *for high-skilled and* $\kappa=1$ *and* $\overline{\theta}$ *for low-skilled agents.*

The principal's profit with an unmotivated agent results as:

$$\Pi_{FB}^{m*}=(1-\alpha)\left(\frac{\alpha\kappa}{\theta}\right)^{\frac{\alpha}{1-\alpha}}\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}}, \qquad (3.10)$$

[17] The existence of agencies, like ProjectsAbroad (http://www.projects-abroad.de) or Experiment e.V. (http://www.experiment-ev.de), that are paid by people from industrial countries to arrange a possibility to volunteer for themselves in Latin America or Africa, shows that intrinsic motivation can overcompensate agents over their cost of effort.

and is with a motivated agent:

$$\Pi_{FB}^{0*} = (1-\alpha)\left(\frac{\alpha\kappa}{\theta}\right)^{\frac{\alpha}{1-\alpha}} \varphi^{\frac{1}{1-\alpha}}. \tag{3.11}$$

Where again, the suitable values of κ and θ have to be replaced, depending on the agent's skill-level.

3.2.3.1.2 Incomplete Information: Second-Best-Solution The second-best solution is valid for $p \in]0;1[$ with p being the probability of meeting an unmotivated agent in a certain skill group. Again, we look at the situation, where the principal meets a high-skilled agent. The principal does not know the motivational type of the agent, but she knows $\underline{p}$ and maximizes her expected profit from a menu of contracts with respect to the participation constraints of both motivational types of agents and under incentive compatibility, where superscripts m and 0 stand for motivated and unmotivated agents, respectively.

$$E[\Pi] = \underline{p} \cdot [\varphi(q^0)^\alpha - w^0] + (1-\underline{p}) \cdot [\varphi(q^m)^\alpha - w^m]$$

The principal calculates the second-best contracts under asymmetric information from:

$$\max_{\{(w^0,q^0);(w^m,q^m)\}} E[\Pi]$$

subject to

$$\begin{aligned}
u^m = \kappa w^m - \underline{\theta} q^m + \eta(q^m)^\alpha &\geq 0 && (3.12)\\
u^0 = \kappa w^0 - \underline{\theta} q^0 &\geq 0 && (3.13)\\
\kappa w^m - \underline{\theta} q^m + \eta(q^m)^\alpha &\geq \kappa w^0 - \underline{\theta} q^0 + \eta(q^0)^\alpha && (3.14)\\
\kappa w^0 - \underline{\theta} q^0 &\geq \kappa w^m - \underline{\theta} q^m && (3.15)
\end{aligned}$$

The motivated (unmotivated) agents' participation constraint (3.12) ((3.13)) assures no less than their outside utility to every agent. Incentive compatibility ((3.14) and (3.15)) means, that both types cannot improve their situation by choosing the contract that was written for the other type, as the other's combination of lump sum transfer and quantity leads to the same or a lower utility as the own contract.

In solving this optimization programme, we apply the common technique[18] to stepwise simplify inequalities (3.12) to (3.15) to equalities and plug them into the objective function to derive the optimal separating menu of contracts. Implicitly we exclude corner solutions with this procedure[19], hence in a second step, we need to check whether the principal always prefers to offer a separating menu of contracts or if there exist conditions that make her prefer to offer only one contract, although $p \in]0, 1[$.

Now we want to eliminate side conditions that are already fulfilled by other conditions: From combining (3.12) with (3.14) and (3.13) with (3.15) we derive

$$\begin{aligned} u^m = \kappa w^m - \underline{\theta} q^m + \eta (q^m)^\alpha &\geq \kappa w^0 - \underline{\theta} q^0 + \eta (q^0)^\alpha \\ u^0 = \kappa w^0 - \underline{\theta} q^0 &\geq \kappa w^m - \underline{\theta} q^m \end{aligned}$$

It follows that:

$$u^m \geq u^0 + \eta (q^0)^\alpha \quad (3.16)$$

$$u^0 \geq u^m - \eta (q^m)^\alpha \quad (3.17)$$

By inserting the motivated agent's participation constraint (3.13) into (3.16) and with $\eta q^\alpha > 0$, for all $q > 0$ a motivated agent's utility is greater than or equal to zero, which is the same as (3.12):

$$u^m \geq \kappa w^0 - \underline{\theta} q^0 + \eta (q^0)^\alpha \quad (3.18)$$

Since the principal is in the position to make a take-it-or-leave-it-offer to the agent and her profit decreases with increasing w, the principal chooses the lowest possible transfer which will just satisfy a motivated agent's incentive constraint and sets (3.18) to equality. Thus, solving for w^m, the transfer to the motivated

[18]See, e.g. Laffont and Martimort (2002) or Bolton and Dewatripont (2005).

[19]Delfgaauw and Dur (2008) are unaware of this problem and thus not fully specify the solution. As we will see in Result 4, also in their model there must be a range of p that their analysis does not cover.

agent amounts to

$$w^m = w^0 - \frac{\theta}{\kappa}(q^0 - q^m) + \frac{\eta}{\kappa}[(q^0)^\alpha - (q^m)^\alpha]. \tag{3.19}$$

Inserting (3.12) and the result for w^m into (3.17), we get $u^0 \geq u^0 + \frac{\eta}{\kappa}[(q^0)^\alpha - (q^m)^\alpha]$. It follows:

$$\frac{\eta}{\kappa}[(q^0)^\alpha - (q^m)^\alpha] \leq 0$$

which means, that $q^{0*} < q^{m*}$ has to be valid in the optimum, as motivational utility is increasing in the quantity produced ($\eta\alpha(q)^{\alpha-1} > 0$). The unmotivated agent gets less than u^0 by selecting the "wrong" contract and he does not have any incentive to mimic the motivated type, which we see from (3.17). The principal chooses the lowest possible transfer to the unmotivated type, which is

$$w^0 = \underline{\theta} q^0. \tag{3.20}$$

If (3.20) is put into the equation for w^m (3.19), the result is:

$$w^m = \frac{\theta}{\kappa} q^m + \frac{\eta}{\kappa}[(q^0)^\alpha - (q^m)^\alpha]. \tag{3.21}$$

This leads to $u^{m*} = \eta(q^{0*})^\alpha$, which is the motivated agent's information rent.[20] It is positive as $q^{0*} > 0$. The principal's maximization of $E[\Pi]$ can be simplified by inserting the feasible transfers into the objective function:

$$\max_{\{q^0;q^m\}} \underline{p} \cdot \left[\varphi(q^0)^\alpha - \frac{\theta}{\kappa} q^0\right] + (1-\underline{p}) \cdot \left[\varphi(q^m)^\alpha - \frac{\theta}{\kappa} q^m - \frac{\eta}{\kappa}[(q^0)^\alpha - (q^m)^\alpha]\right]$$

Second-best quantities are given by the first order conditions:

$$\alpha\left[\varphi - \frac{1-p}{p} \cdot \frac{\eta}{\kappa}\right](\underline{q}^{0*})^{\alpha-1} \quad = \quad \frac{\theta}{\kappa} \tag{3.22}$$

$$\alpha\left[\varphi + \frac{\eta}{\kappa}\right](\underline{q}^{m*})^{\alpha-1} \quad = \quad \frac{\theta}{\kappa} \tag{3.23}$$

[20]As the motivational return from q^0 is lower than from q^m with $\eta(q)^\alpha$ being concave, w^m might be negative in the second-best solution, but the motivated agent's utility is positive. But the example in 3.2.3.2 shows that there are parameters that imply positive transfers.

From equations (3.20) to (3.23) we get as the optimal menu of contracts offered to a high-skilled agent:

$$\{\underline{w}^{0*};\underline{q}^{0*}\} = \left\{\frac{\underline{\theta}}{\kappa}\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}};\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}}\right\} \tag{3.24}$$

$$\{\underline{w}^{m*};\underline{q}^{m*}\} = \left\{\frac{\underline{\theta}}{\kappa}\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi + \frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}} + \frac{\eta}{\kappa}\left[\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)\right]^{\frac{\alpha}{1-\alpha}} - \left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi + \frac{\eta}{\kappa}\right)\right]^{\frac{\alpha}{1-\alpha}}\right];\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi + \frac{\eta}{\kappa}\right)\right]^{\frac{1}{1-\alpha}}\right\}, \tag{3.25}$$

and by setting $\kappa = 1$ and replacing $\underline{\theta}$ with $\overline{\theta}$ the second-best menu of contracts to a low-skilled agent results:

$$\{\overline{w}^{0*};\overline{q}^{0*}\} = \left\{\overline{\theta}\left[\frac{\alpha}{\overline{\theta}}\left(\varphi - \frac{1-p}{p}\cdot\eta\right)\right]^{\frac{1}{1-\alpha}};\left[\frac{\alpha}{\overline{\theta}}\left(\varphi - \frac{1-p}{p}\cdot\eta\right)\right]^{\frac{1}{1-\alpha}}\right\}, \tag{3.26}$$

$$\{\overline{w}^{m*};\overline{q}^{m*}\} = \left\{\overline{\theta}\left[\frac{\alpha}{\overline{\theta}}(\varphi+\eta)\right]^{\frac{1}{1-\alpha}} + \eta\left[\left[\frac{\alpha}{\overline{\theta}}\left(\varphi - \frac{1-\overline{p}}{\overline{p}}\cdot\eta\right)\right]^{\frac{\alpha}{1-\alpha}} - \left[\frac{\alpha}{\overline{\theta}}(\varphi+\eta)\right]^{\frac{\alpha}{1-\alpha}}\right];\left[\frac{\alpha}{\overline{\theta}}(\varphi+\eta)\right]^{\frac{1}{1-\alpha}}\right\}. \tag{3.27}$$

Whether these contracts are maximizing the principal's yield function depends on the second order conditions:

$$\alpha(\alpha-1)\left[\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right](\underline{q}^{0*})^{\alpha-2} \overset{!}{<} 0 \tag{3.28}$$

$$\alpha(\alpha-1)\left[\varphi + \frac{\eta}{\kappa}\right](\underline{q}^{m*})^{\alpha-2} \overset{!}{<} 0 \tag{3.29}$$

The condition for the motivated agent's contract (3.29) is always fulfilled as

$\alpha \in]0,1[$ at both skill-levels. If (3.28) is fulfilled, depends on the sign of the term in squared brackets. As the rest is negative, the second order condition is fulfilled for $\underline{p}\varphi - (1-\underline{p})\frac{\eta}{\kappa} > 0$. This leads to the conditions

$$\underline{p} > \tilde{p} := \frac{\eta}{\varphi\kappa + \eta} \text{ , or } \overline{p} > \tilde{\tilde{p}} := \frac{\eta}{\varphi + \eta} \tag{3.30}$$

for contracting with a high- or a low-skilled agent, respectively. From applying the implicit functions theorem on (3.22), we see that $\underline{q}^{0*}$ increases, the higher the proportion of unmotivated agents, whenever the second order condition in $\underline{q}^{0*}$, which is named SOC($\underline{q}^{0*}$), is negative:

$$\frac{d\underline{q}^{o*}}{d\underline{p}} = -\frac{\frac{\eta}{\kappa}\alpha(\underline{q}^{0*})^{\alpha-1}}{\text{SOC}(\underline{q}^{0*})} \tag{3.31}$$

This, of course, is valid for the same situation with a low-skilled agent, too.

RESULT 4: *Under incomplete information and $\underline{p} > \tilde{p}$ ($\overline{p} > \tilde{\tilde{p}}$), the optimal incentive compatible menu of contracts offered by the firm to a high-skilled (low-skilled) agent is defined by (3.24) and (3.25) ((3.26) and (3.27)). While the unmotivated type's contract changes with p, for the motivated only the optimum transfer depends on p, and thus he produces the efficient quantity at both skill-levels.*

The agents' respective utilities from being high-skilled are:

$$\underline{u}^{0*} = 0 \text{ and } \underline{u}^{m*} = \eta\left[\frac{\alpha\kappa}{\underline{\theta}}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)\right]^{\frac{\alpha}{1-\alpha}} \tag{3.32}$$

and from being low-skilled:

$$\overline{u}^{0*} = 0 \text{ and } \overline{u}^{m*} = \eta\left[\frac{\alpha}{\overline{\theta}}\left(\varphi - \frac{1-\overline{p}}{\overline{p}}\eta\right)\right]^{\frac{\alpha}{1-\alpha}} . \tag{3.33}$$

The second equations of (3.32) and (3.33) show the positive interdependence between the motivated agent's utility and the fraction p of unmotivated agents.

The utility of motivated agents in the separating equilibrium is called information rent. It is the price the principal pays to a motivated agent over his outside option in order to make him accept a contract that leaves a higher profit to the principal than in a situation when the agent accepted the contract for the unmotivated agent. If there are no unmotivated agents in the qualification group, motivated agents also get zero utility because the principal knows the agent's type for sure ($p = 0$). The consequence for the principal is: The higher the fraction of unmotivated agents at a certain skill-level, the higher the transfer she offers the motivated agent has to be, which reduces her expected profit with a high-skilled type:

$$E[\underline{\Pi}_{SB}] = (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left[\underline{p}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} + (1-\underline{p})\left(\varphi + \frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}}\right] \tag{3.34}$$

This solution is valid for contracting with low-skilled agents, too when we insert $\overline{\theta}$ instead of $\underline{\theta}$ and set $\kappa = 1$.

In the preceding analysis we simplified side conditions by eliminating fulfilled conditions and replacing the transfers. As already mentioned, going that way to solve the second stage of the model, we implicitly assume that the principal offers a menu of separating contracts[21] instead of one contract to both motivational types. That is why we need to check if there is no shut-down of one of the types in the optimum as the chosen way to solve the problem would not give such a solution. The following question now comes up: Does there exist a situation, in which it is more profitable for the principal to offer only the first-best contract for one of the motivational types instead of offering an incentive compatible menu of contracts? In this situation the expected payoff from the first-best contract would be higher than the expected payoff from the incentive compatible menu of contracts.

[21]If we look at the motivated agents' utilities in the ranges of $\underline{p}$ and $\overline{p}$ where the SOC is not negative, we find that the participation constraints for these agents are not fulfilled any more. That means, even if principals would offer this menu, the motivated would not accept the contracts written to them but those for unmotivated agents. Hence, a menu that is offered whenever (3.30) is not fulfilled is not a separating menu of contracts.

3.2.3.1.3 Separation vs. Pooling Under Incomplete Information As resumed by Result 4, for $\underline{p} \leq \tilde{p}$ ($\overline{p} \leq \tilde{\tilde{p}}$) the separating menu of contracts is not maximizing the principal's yield function. But which alternatives does the principal have? If she offers both first-best contracts[22], the motivated agent will accept the contract of the unmotivated agent as it returns him a higher utility. The principal foregoes the higher profit from a contract with a motivated agent who is willing to accept a "stricter" contract and work for a relatively lower lump sum transfer, if he does not have a choice. So if the principal offers $\{w_{FB}^{0*}, q_{FB}^{0*}\}$, she never offers $\{w_{FB}^{m*}, q_{FB}^{m*}\}$ at the same time, as neither the motivated nor the unmotivated agent would accept the second contract. To see what happens in a situation where separation is not optimal, we compare the outcomes for principals when only *one* of the first-best contracts or the second-best menu of contracts is offered. Providing only the first-best contract for motivated agents would lead to a shut-down of the unmotivated, as they have a negative utility from this contract. Offering only the first-best contract of the unmotivated agent does not result in shutdown of the motivated agent, but in pooling of both types.

The principal has the choice of contract offer, agents' utilities from offered contracts are always at least zero and the separating menu is incentive compatible, thus the contracts at choice for the principal will always be accepted, except the first-best contract offer to a motivated agent, which gives a negative utility to an unmotivated agent. Hence, we only need to analyze the principal's situation. To simplify notation the following scenarios are labeled:

> POOLING The first-best-contract for the unmotivated agent (3.11) is offered:
> Π_{FB}^{0*}.
>
> SHUTDOWN The first-best-contract for the motivated agent (3.10) is offered:
> $(1-p)\Pi_{FB}^{m*}$.
>
> SEPARATION The separating menu of contracts (3.34) is offered:
> $E[\Pi_{SB}]$.

[22]See Result 3.

POOLING is the situation with a principal only offering the first-best contract for unmotivated agents and both types are willing to accept. In SHUTDOWN the first-best contract for motivated agents is offered, so only motivated agents accept this contract and profits have to be weighted by the fractions of motivated types at the respective skill-level. For unmotivated agents this contract would yield a negative utility. In SEPARATION the second-best menu of Result 4 is offered.[23]

At first SHUTDOWN and POOLING are compared: For $(1-p)\Pi_{FB}^{m*} - \Pi_{FB}^{0*} > 0$ the principal prefers the first-best contract for a motivated agent to offering the first-best contract for a unmotivated in spite of not all agents accepting the contract. We again look at the situation, when the principal offers a contract to a high-skilled agent.

$$(1-\underline{p})(1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} - (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\varphi^{\frac{1}{1-\alpha}} > 0$$

It follows that for

$$\underline{p} < \hat{p} := 1 - \left(\frac{\eta}{\kappa\varphi+\eta}\right)^{\frac{1}{1-\alpha}} \tag{3.35}$$

the principal offers the first-best contract for high-skilled motivated agents. For low-skilled agents, the critical value is $\overline{p} < \hat{\hat{p}} := 1 - \left(\frac{\eta}{\varphi+\eta}\right)^{\frac{1}{1-\alpha}}$.

The next step is to compare SHUTDOWN and SEPARATION. From $E[\Pi] - (1-p)\Pi_{FB}^{m*} > 0$ results as the critical inequality:

$$(1-\alpha)\left(\underline{p}\varphi - (1-\underline{p})\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} > 0 \tag{3.36}$$

The second term in brackets determines the algebraic sign. So from $\underline{p}\varphi - (1-\underline{p})\frac{\eta}{\kappa} > 0$ follows

$$\underline{p} > \tilde{p} \text{ or } \overline{p} > \tilde{\tilde{p}} \tag{3.37}$$

as the condition for a separating contract offer. Which is just the case whenever

[23]The mathematical derivations of the critical values of p are given in Appendix 3.3.3.

the separating menu is not maximizing $E[\Pi]$ as stated by Result 4.

If $E[\Pi] - \Pi_{FB}^{0*} > 0$ the principal offers the separating menu of contracts instead of the first-best contract for the unmotivated agents.

$$(1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left[p\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} + (1-p)\left(\varphi - \frac{\eta}{\kappa}\right)\frac{1}{1-\alpha}\right] - (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\varphi^{\frac{1}{1-\alpha}} > 0$$

If simplified, the following inequality results:

$$(1-\alpha)\left[p\left(\varphi - \frac{1-p}{p}\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} + (1-p)(\varphi - \frac{\eta}{\kappa})^{\frac{1}{1-\alpha}} - \varphi^{\frac{1}{1-\alpha}}\right] > 0 \qquad (3.38)$$

This inequality holds for $(1-\alpha)^{-1}$ being an even integer. In those cases, (e.g. $\alpha = 0.5$, $\varphi = 25$ and $\eta = 10$, as in the example in 3.2.3.2) the principal prefers to offer the separating menu of contracts to offering the first-best contract of the unmotivated agents.

Then it follows that the principal either offers the separating menu of contracts or the first-best contract for the motivated type only, depending on the value of p. The contract offers at $p = 0$ and $p = 1$ are taken from the analysis of the first-best case, where the principal only faces one motivational type at each skill-level. With very few unmotivated agents separation does not pay off and shut-down of the unmotivated type results. Figure 3.4 illustrates the relation between the principal's expected gains from the alternative offers. This is comparable to the results by Delfgaauw and Dur (2007), where the least motivated types do not apply for the job as the offered minimum wage does not cover their cost of application.

RESULT 5: *With incomplete information, the principal offers only a separating menu if* $\underline{p} > \tilde{p}$ $(\overline{p} > \tilde{\tilde{p}})$. *Otherwise she offers the first-best contract for motivated agents and there is shut-down of the unmotivated agents.*

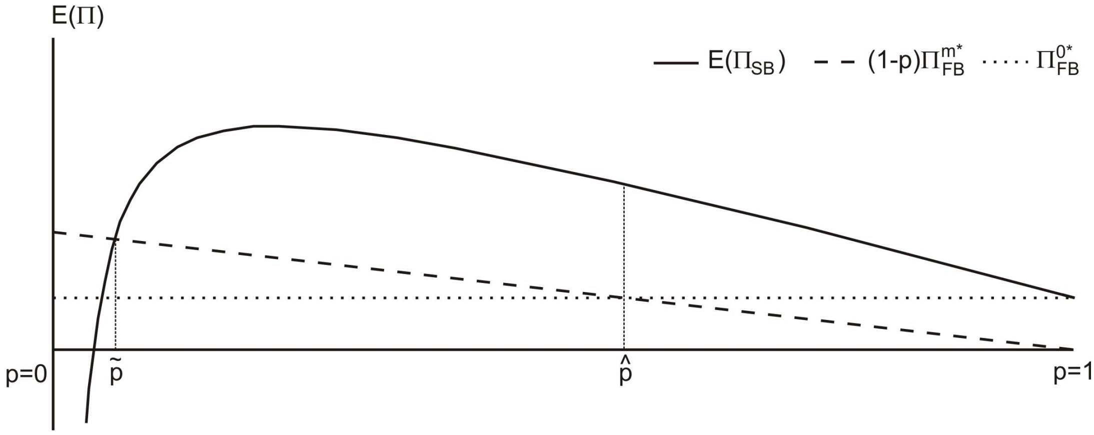


Figure 3.4: Principal's Expected Gain from Different Contracts Depending on p.

3.2.3.2 Coordination of Agents at the Outset

Training costs are a tax on agents' wage, namely: $\hat{\kappa} \cdot w$, with $\hat{\kappa} \in]0,1[$. These are already included in the high-skilled agents' utility from a contract. If motivation is homogenous or a low fraction of unmotivated agents implies their shutdown, agents' utilities are zero and with negative wages for motivated agents the tax becomes a subsidy. One result of the asymmetric information solution is that unmotivated agents of both qualifications only get their reservation utility of zero, that means their utility is independent of qualification. With fixed training costs there would be no investment in qualification by both motivational types: The unmotivated agents do not want to become high-skilled as their utility is independent of qualification and they can never outweigh their qualification costs. Consequently, motivated agents also would not want to become high-skilled as there is only an information rent, which would compensate them for their investment in qualification, if there were also unmotivated agents, in the group of high-skilled. Overall efficiency is achieved, if there are only high-skilled agents. Then total rent, irrespective of distribution, is maximized because there are neither output-distortions nor unmotivated agents, who do not produce as there is no acceptable contract offered to them. If educational investment cost depend on the wage, investing is risk free, even to unmotivated agents as cost can be avoided ex post by not accepting any contract. With $\hat{\kappa} \in]0,1[$ and a heterogenous skill group, there is always at least a small positive amount of utility left to motivated agents.

Training costs depending on the contractual wage set the unmotivated agents indifferent between becoming high-skilled and remaining low-skilled, because both options lead to zero utility. They are assumed to select their qualification at random with equal probabilities. An equal distribution of unmotivated agents over both qualification groups results. With this assumption, a homogenously motivated skill group is excluded, if there is more than one unmotivated agent in the population. As unmotivated agents always just get their outside-option, they cannot improve by deviating from their initial choice.

Motivated decide about their education in a coordination game: The fewer motivated agents are in one's skill group, the higher is utility. This can be seen from equations (3.32) and (3.33): A motivated agent's utility increases with the fraction of unmotivated agents in his skill group. Thus, a Nash-equilibrium is reached, if no motivated agent can improve by changing his skill level, given all others stick to their decisions. But whenever $\underline{p}$ ($\overline{p}$) is smaller than $\tilde{p}$ ($\tilde{\overline{p}}$) from equation (3.30) motivated agents get a zero utility in the respective skill group and have at least a weak incentive to deviate (the other option is at least as good).

For the cases where a principal offers separating contracts we need to go into more detail. The structure of the problem is illustrated by the following example:

Numerical Example

When we look at an example of four agents, two motivated (M_1, M_2) and two unmotivated (U_1, U_2), and assume the same numerical specification as in the example for the continuos case[24] we are able to give the motivated agents' payoffs from becoming high-skilled (H) and remaining low-skilled (L) in payoff-matrices.

For both unmotivated agents being high-skilled $U_1, U_2 \rightarrow (H, H)$ we get:

[24] $\Pi = 25\sqrt{q} - w$, $\eta = 10$, $\hat{\kappa} = 0.2$, $\alpha = 0.5$, $\underline{\theta} = 2$ and $\overline{\theta} = 1$.

		M_2: L	M_2: H
M_1	L	0, 0	0, 75
	H	75, 0	50, 50

Here, the equilibrium qualification decisions are $U_1, U_2, M_1, M_2 \rightarrow (H, H, H, H)$, that is, $\underline{p} = 0.5$ and $\overline{p} = 0$.

For one high- and one low-skilled unmotivated agent (U_1, $U_2 \rightarrow (H, L)$ or U_1, $U_2 \rightarrow (L, H)$):

		M_2: L	M_2: H
M_1	L	12.5, 12.5	37.5, 50
	H	50, 37.5	0, 0

The equilibria are the anti-coordination strategy combinations of unmotivated and motivated agents, which lead to $\underline{p} = \overline{p} = 0.5$.

For two low-skilled unmotivated agents (U_1, $U_2 \rightarrow (L, L)$):

		M_2: L	M_2: H
M_1	L	37.5, 37.5	50, 0
	H	0, 50	0, 0

also motivated agents are in equilibrium low-skilled: $U_1, U_2, M_1, M_2 \rightarrow (L, L, L, L)$ with $\underline{p} = 0$ and $\overline{p} = 0.5$.

To give the equilibrium fractions of unmotivated agents at both skill-levels, we need to set motivated agents indifferent between being high- or low-skilled. Unmotivated agents are always indifferent between both options as their utility from the second best contract is always zero (compare equations (3.32) and (3.33)).

When we assume a countable number of agents, we can set $\overline{x}$ as the number of unmotivated and low-skilled agents and $\underline{x}$ as their high-skilled counterparts. As unmotivated agents are indifferent between the qualification alternatives, we can set $\overline{x} = \underline{x} = x$. The same notation is applied to the total number of agents n with $\overline{n} = n - \underline{n}$ describing the interdependence between the number of low-skilled $\overline{n}$ and high-skilled $\underline{n}$ agents. A high-skilled motivated agent does not regret his investment for:

$$\begin{aligned} \Delta u_I^m &= u_I^m(low) - u_I^m(high) \\ &= \eta \left[\frac{\alpha}{\overline{\theta}} \left(\varphi - \frac{n - \underline{n} + 1 - x}{x} \eta \right) \right]^{\frac{\alpha}{1-\alpha}} - \eta \left[\frac{\alpha\kappa}{\underline{\theta}} \left(\varphi - \frac{\underline{n} - x}{x} \cdot \frac{\eta}{\kappa} \right) \right]^{\frac{\alpha}{1-\alpha}} \cdot (1-\kappa) \\ &\leq 0 \end{aligned}$$

A motivated agent prefers to remain low-skilled instead of becoming high-skilled for:

$$\begin{aligned} \Delta u_{II}^m &= u_{II}^m(high) - u_{II}^m(low) \\ &= \eta \left[\frac{\alpha\kappa}{\underline{\theta}} \left(\varphi - \frac{\underline{n} + 1 - x}{x} \cdot \frac{\eta}{\kappa} \right) \right]^{\frac{\alpha}{1-\alpha}} \cdot (1-\kappa) - \eta \left[\frac{\alpha}{\overline{\theta}} \left(\varphi - \frac{n - \underline{n} - x}{x} \eta \right) \right]^{\frac{\alpha}{1-\alpha}} \\ &\leq 0 \end{aligned}$$

The next step is to calculate the critical values of $x/\underline{n}$ for both inequalities to find a range of $\underline{p} = x/\underline{n}$ where both inequalities are fulfilled:

$$\underline{p} \geq \frac{x}{\underline{n}_I} = \frac{x\eta(\underline{\theta} + \overline{\theta})}{\overline{\theta}x(\kappa\varphi - \eta) - \underline{\theta}(\varphi x - (n - x)\eta) + \underline{\theta}\eta}$$

$$\underline{p} \leq \frac{x}{\underline{n}_{II}} = \frac{x\eta(\underline{\theta} + \overline{\theta})}{\overline{\theta}x(\kappa\varphi - \eta) - \underline{\theta}(\varphi x - (n - x)\eta) - \overline{\theta}\eta}$$

Because we are looking for a $\underline{p}$ that fulfills both inequalities, we look for combinations of the variables that yield $\frac{x}{\underline{n}_I} \leq \frac{x}{\underline{n}_{II}}$. This is given for

$$\overline{\theta}x(\kappa\varphi - \eta) - \underline{\theta}(\varphi x - (n - x)\eta) - \overline{\theta}\eta > 0,$$

which is, the denominator of $\frac{x}{\underline{n}_{II}}$ is positive. When we apply the same reasoning for low-skilled agents we have:

$$\overline{p} \geq \frac{x}{\overline{n}_I} = \frac{x\eta(\underline{\theta} + \overline{\theta})}{n\eta(\underline{\theta} + \overline{\theta}) - \overline{\theta}x(\kappa\varphi - \eta) + \underline{\theta}(\varphi x - (n - x)\eta) + \overline{\theta}\eta}$$

$$\overline{p} \leq \frac{x}{\overline{n}_{II}} = \frac{x\eta(\underline{\theta}+\overline{\theta})}{n\eta(\underline{\theta}+\overline{\theta}) - \overline{\theta}x(\kappa\varphi-\eta) + \underline{\theta}(\varphi x-(n-x)\eta) - \underline{\theta}\eta}$$

This leads to a valid range for $n\eta(\underline{\theta}+\overline{\theta})-\overline{\theta}x(\kappa\varphi-\eta)+\underline{\theta}(\varphi x-(n-x)\eta)+\overline{\theta}\eta > 0$. Hence, the equilibrium qualification rates of high- and low-skilled motivated agents are defined:

Result 6:

a. *As only the first-best contract for motivated agents is offered for* $\underline{p} < \tilde{p}$ ($\overline{p} < \tilde{\tilde{p}}$)*, all results of the agents' qualification decisions that imply these fractions of unmotivated agents at both skill-levels are equilibria.*

b. *If separating menus are offered,* $\max\{\frac{x}{\underline{n}_I}, \tilde{p}\} \leq \underline{p} \leq \frac{x}{\underline{n}_{II}}$ *and* $\max\{\frac{x}{\overline{n}_I}, \tilde{\tilde{p}}\} \leq \overline{p} \leq \frac{x}{\overline{n}_{II}}$ *define the equilibrium qualification rates for unmotivated agents at both skill-levels, as deviation from qualification choice does not pay off to any agent.*

What follows from Results 5 and 6 are two possible situations: On the one hand, the agents' qualification decision in combination with given motivational types can lead to low fractions of unmotivated agents at both skill-levels and principals offer only the first-best contract to motivated agents.[25] On the other, the coordination game of stage one may result in heterogenous agent-groups at the skill-levels, such that the separating menu of contracts is offered. If we want to compare these alternatives from a welfare perspective, the separating menu would lead to higher overall production as under shut-down not the whole workforce produces and thus the pie to divide between principals and agents is larger in the first situation.

This type of coordination problem arises whenever agents endogenously choose one of their characteristics and in addition determine with this decision the distribution of unobservable types for a later screening-game. In our model even the decision about an observable characteristic (skill-type) influences

[25]If a motivated agent deviates,p falls for the skill-level he moves to. Hence $p_{new} < \tilde{p}_{new}$ is still valid. In the case of p_{old} becoming larger than $\tilde{p}_{old}$ this does not have an influence on the deviating agent's decision.

the distribution of unobservable motivation relevant to principals. To give an example of a decision about an unobservable characteristic, that is relevant to a principal's contract offer, we complete the theoretical model of Kirstein and Bleich (2008) by analyzing the agents' coordination problem in a situation with screening on unobservable endogenous qualification in the Appendix (3.3.4).

3.2.4 Summary and Conclusion

In this chapter we analyzed a screening game of intrinsic motivation with endogenous qualification. A motivational term was introduced into the agent's utility function to reflect intrinsic work motivation. At first, we assume a continuous distribution of motivation. The principal offers menus of contracts depending on the distribution of motivational types at the respective skill-levels. Agents reveal their type by choosing the suitable contract and only the least motivated type gets zero, all others get a positive rent. On the first stage of this game, becoming high-skilled is either the (weakly-) dominating strategy for all agents or for none of them. This stems from the assumption that the principal does not update his belief regarding the distribution of unmotivated agents inside the two skill groups and thus makes contract offers suiting the initial distribution of motivation. Decisions only depend on qualification cost $\hat{\kappa}$, and the skill parameters $\underline{\theta}$ and $\overline{\theta}$, but not on motivation itself. We also gave an intuitive example with a well behaved solution.

In the second part, a situation with discrete motivational levels, *motivated* and *unmotivated*, was described and for some fractions of unmotivated agents in a skill group, we found shut-down of unmotivated types: Only the suitable first-best contract for motivated agents is offered in both skill groups. In a situation with very few unmotivated agents, the principal wants to avoid selection cost in the form of paying an information rent to the motivated agent. As the probability of meeting an unmotivated type is low, she risks that this type will not accept the motivated's first-best contract as his utility from it is negative. But as the first-best outcome has the highest gain for the principal, her expected payoff from this option is higher than offering a selecting menu of contracts. This result is untypical for a screening model as full separation of types in the second-best situation is most frequent.[26] Then, we looked at the motivated agents' qualification decision at the first stage and found that unmotivated agents are always indifferent when deciding about investing into qualification as their utility is always zero. For motivated agents the profitability of investing depends on the fractions of unmotivated agents at both skill-levels, and so does the equilibrium qualification decision.

A new assumption of this approach, is that qualification cost are a fraction of the wage instead of having a fixed value. The mathematical/practicability reasons for this assumption are given in Appendix 3.3.2. We showed that a system of proportional qualification cost leads to a higher overall qualification than fixed value qualification cost. Motivated only profit from being high-skilled when there are unmotivated agents the principal needs to select them from. If investing is risk-free to unmotivated agents, they may also become high-skilled and the overall qualification rate increases. Thus production increases and hence efficiency. If the state wants to increase efficiency, he provides possibilities to finance qualification measures by income taxes to the high-skilled.

This model's structure may also be applied to a situation where agents differ in innate abilities and are able to decide about their qualification. For example, the ability to work in a team does not have an influence on the cost of taking part in qualification measures. Hence, by choosing their qualification level, team workers influence their distribution, that becomes relevant when principals screen for abilities.

When we transfer these results back to the introducing example of employers' selection of university graduates, we can state, that university access may not be regulated by fixed-amount tuition fees. This would keep the unmotivated prospective employees and in consequence the motivated from studying[27], as they only profit from their degree if also unmotivated can reach one. If the state or universities can afford that, they should provide educational loans with repayment depending on the students' work situation after graduating.

[26]See e.g. Bolton and Dewatripont (2005), p. 94.
[27]If there are no other sources than their own to finance studies.

3.3 Appendix

3.3.1 The Motivational Screening-Game

Although screening-models in the literature are traditionally formulated as in Section 3.2.2, we want to state it here as it would be done in game-theory to provide another view and starting point for readers coming from that area of theoretical modeling.

...with Continuously Distributed Motivation:

We have two types of players: Agents A_i with $i = 1, ..., n$ and Principals P_j with $j = 1, ..., n$. The timing of the game is as follows:

1. Nature draws the motivational type η_{ik} for each agent from the set of feasible types $\mathsf{E}= [\underline{\eta}, \overline{\eta}]$ according to the probability distribution $F(\eta)$ with density $f(\eta)$, which is common knowledge to all A_i and P_i.

2. Each agent observes his own motivational type η_{ik} and decides about his qualification θ_l which can either be high ($\underline{\theta}$) or low ($\overline{\theta}$), with θ_l being the cost of producing one quantity unit and $\underline{\theta} < \overline{\theta}$.

3. All agents and principals are matched randomly into pairs.

4. Each principal P_j observes θ_{il} of his agent A_i but not his motivational type η_{ik}. A principal only knows $F(\eta)$.

5. Principals offer a menu of contracts consisting of combinations of lump sum wage w from the set of feasible wages $\mathsf{W}\in \mathbb{R}$ and production quantity q from the set of feasible quantities $\mathsf{Q}= [0, r] \subset \mathbb{R}_+$.

6. Agents decide whether to accept one of the contract offers from their principal or not.

7. Payoffs are given by: $u_i(\eta_{ik}, \theta_{il}, w, q)$ for agent A_i and $\Pi_j(w, q)$ for principal P_j.

The game-tree for agent A_i and principal P_j is given in Figure 3.5. Nature draws η_{ik} for each agent. This is equivalent to nature drawing randomly from a set that contains all possible combinations of η_{ik} for all agents A_i. But as this is hard to depict, we decide in favor of explanatory content and let nature draw η_{ik} for each single agent. Knowing their own η_{ik} agents decide about their own skill-level θ_{il}. Then the initial distribution of motivation $F(\eta)$ which applies to high- and low-skilled agents is announced to the principals, in our model we assume that principals do not try to derive the actual distribution of motivation that results from the agents qualification decisions. Hence, there are two different information sets for the principal, namely high- ($\underline{\theta}$) and low-skilled ($\overline{\theta}$) agents, where the principal assumes for both the same distribution $F(\eta)$. The principal offers contracts $[w(\eta), q(\eta)]$ for all possible η and the agent chooses to accept one or none of them.

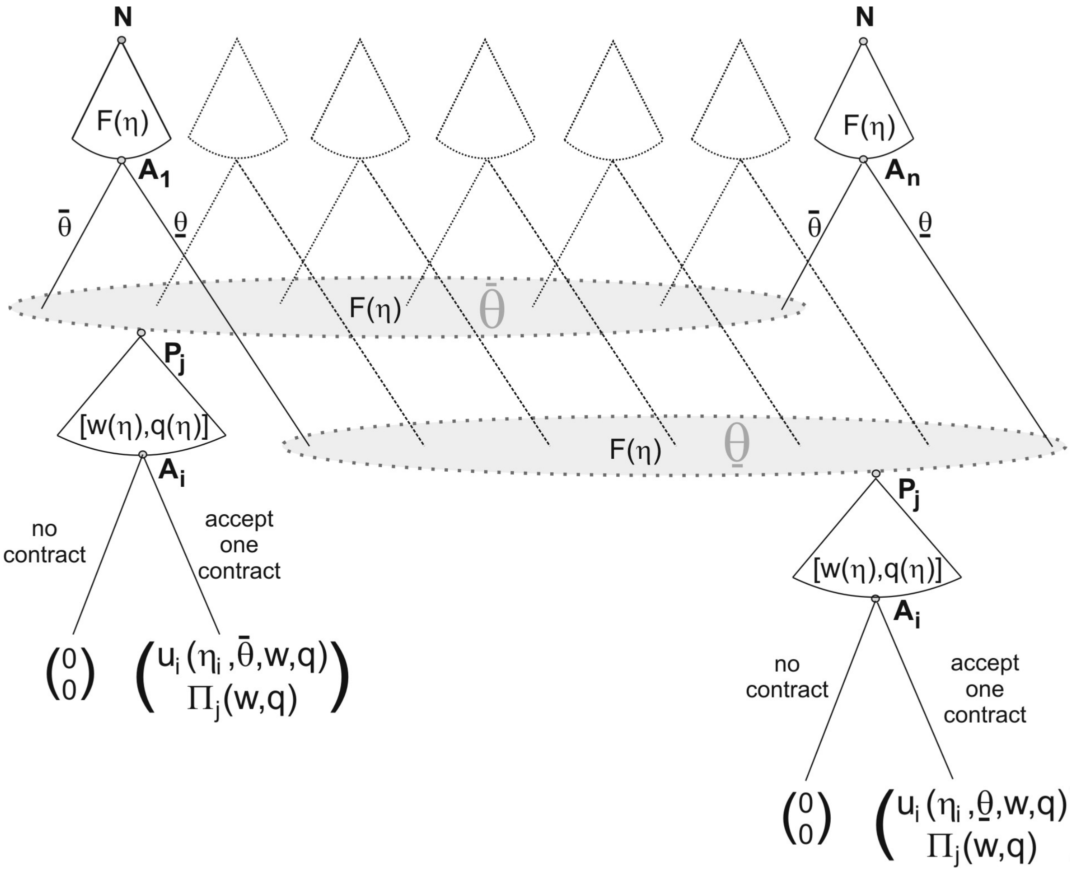


Figure 3.5: Game-Tree: Screening on Continuous Motivation

... with Two-Point Distributed Motivation:

We have two types of players: Agents A_i with $i = 1, ..., n$ and Principals P_j with $j = 1, ..., n$. Agents' qualification decisions have an influence on the motivational distributions at both skill-levels. The timing of the game is as follows:

1. Nature draws the motivational type η_{ik} for each agent from the set of feasible types $\mathsf{E} = \{\underline{\eta}, \overline{\eta}\}$ with the probability t of being unmotivated ($\underline{\eta}$).

2. Agents each observe their own motivational type η_{ik} and decide about their qualification θ_l which can either be high ($\underline{\theta}$) or low ($\overline{\theta}$), with θ_l being the cost of producing one quantity unit and $\underline{\theta} < \overline{\theta}$.

3. The resulting frequencies of unmotivated agents, which are the probabilities of meeting an unmotivated agent to the principals, are announced for both skill-levels: $\underline{p}$ for high-skilled and $\overline{p}$ for low-skilled.

4. All agents and principals are matched randomly into pairs.

5. Each principal P_j observes θ_{il} of his agent A_i but not his motivational type η_{ik}.

6. Principals offer a menu of contracts consisting of up to two combinations of a lump sum wage w from the set of feasible wages $\mathsf{W} \in \mathbb{R}$ and a production quantity q from the set of feasible quantities $\mathsf{Q} = [0, r] \subset \mathbb{R}_+$.

7. Agents decide whether to accept one of the contract offers from their principal or not.

8. Payoffs are given by: $u_i(\eta_{ik}, \theta_{il}, w, q)$ for agent A_i and $\Pi_j(w, q)$ for principal P_j.

The game-tree is given in Figure 3.6 for agent A_i and principal P_j. That a principal offers a menu of contracts, is described by the triangulars with one rounded side.

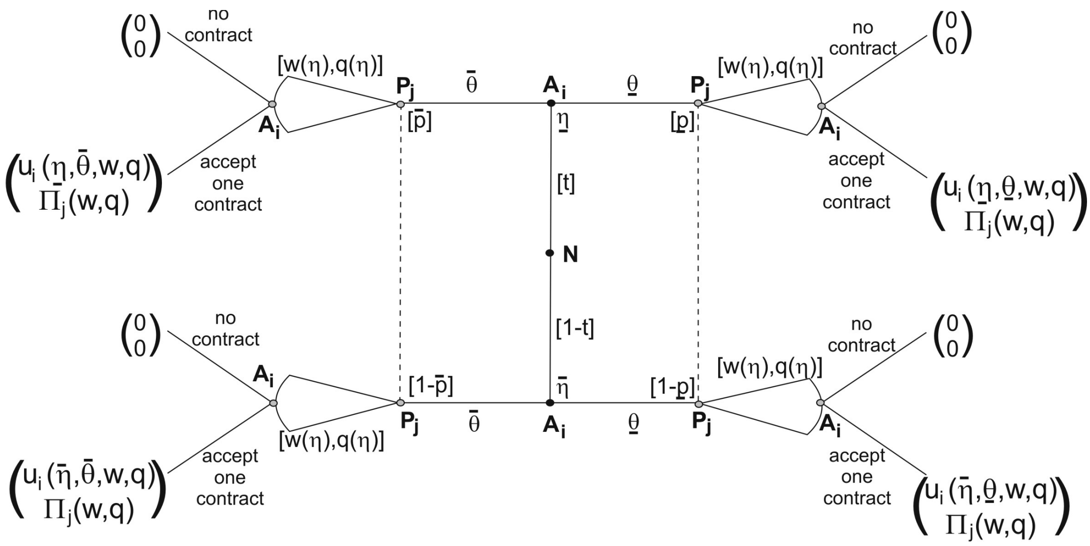


Figure 3.6: Game-Tree: Screening on Two-Point Distributed Motivation

3.3.2 A Note on Outside Options and Qualification Costs

In Section 3.2.2.1 we assumed the agents' outside options to be zero. As qualification cost are a fraction of the contracted wage this seems a quite restrictive assumption. But when looking at the different possibilities the resulting outcome leads to the same qualitative solution as the simplified version does.

The quantity choice is not influenced by a positive outside-option as it drops out if utility is derived with respect to quantity. So the difference is only a redistribution from the principal to the agent.

With fixed cost of qualification, qualification is no longer free for an unmotivated agent and he will never invest in high qualification. If there are no unmotivated agents at the high skill-level, it also does not pay off to the motivated agents to invest in qualification as they get no information rent and are worse off if becoming high-skilled.

If education is offered by government, its aim function could be overall welfare, which we define as the sum of gains to agents and principals. The more is produced the larger is the pie to divide between principal and agent up to the optimal production quantities determined in the first-best solution. So overall welfare is determined by production. High qualification leads to higher production, and thus the state wants as much agents to become highly qualified as possible. As motivated agents only take part in education if unmotivated agents do, they need to be at least indifferent regarding their decision to invest.

3.3.3 Comparison of Scenarios

Shutdown vs. Pooling

If $(1-p)\Pi_{FB}^{m*} - \Pi_{FB}^{0*} \geq 0$ the principal prefers offering the first-best contract for motivated types over offering the first-best contract for unmotivated agents in a situation with $0 < p < 1$. In the following the range of $\underline{p}$ is derived that validates this inequality:

$$\begin{aligned}
(1-\underline{p})(1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left(\varsigma+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} - (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\varsigma^{\frac{1}{1-\alpha}} &> 0 \\
(1-\underline{p})\left(\varsigma+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} - \varsigma^{\frac{1}{1-\alpha}} &> 0 \\
\frac{\left(\varsigma+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} - \varsigma^{\frac{1}{1-\alpha}}}{\left(\varsigma+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}}} &> \underline{p}
\end{aligned}$$

$$\underline{p} < \hat{p} := 1 - \left(\frac{\varphi}{\varphi+\frac{\eta}{\kappa}}\right)^{\frac{1}{1-\alpha}}.$$

For low-skilled unmotivated agents, the critical range is given by:

$$\overline{p} < \hat{\hat{p}} := 1 - \left(\frac{\varphi}{\varphi+\eta}\right)^{\frac{1}{1-\alpha}}.$$

Separation vs. Shutdown

Although by offering only the first best contract to the motivated agent, a principal has a chance to get the maximum of possible payoffs, she risks meeting an unmotivated agent who will not accept the contract. A separating contract could, depending on $\underline{p}$ yield a higher expected gain to the principal, whenever

$$\begin{aligned} E[\Pi] - (1-\underline{p})\Pi_{FB}^{m*} &> 0 \\ (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left[\underline{p}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right) + (1-\underline{p})\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}}\right] & \\ -(1-\underline{p})(1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} &> 0 \\ \underline{p}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} &> 0 \end{aligned}$$

It follows as the critical values of $\underline{p}$ and thus $\overline{p}$:

$$\underline{p} > \tilde{p} := \frac{\eta}{\kappa\varphi+\eta} \text{ and } \overline{p} > \tilde{\tilde{p}} := \frac{\eta}{\varphi+\eta}$$

Separation vs. Pooling

If the principal decides to offer one pooling-contract the contract will be accepted by both types but she forgoes the additional gain from offering a more suitable contract for the motivated agent.

$$\begin{aligned} E[\Pi] - \Pi_{FB}^{0*} &> 0 \\ (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\left[\underline{p}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right) + (1-\underline{p})\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}}\right] & \\ (1-\alpha)\left(\frac{\alpha\kappa}{\underline{\theta}}\right)^{\frac{\alpha}{1-\alpha}}\varphi^{\frac{1}{1-\alpha}} &> 0 \\ \underline{p}\left(\varphi - \frac{1-\underline{p}}{\underline{p}}\cdot\frac{\eta}{\kappa}\right) + (1-\underline{p})\left(\varphi+\frac{\eta}{\kappa}\right)^{\frac{1}{1-\alpha}} - \varphi^{\frac{1}{1-\alpha}} &> 0 \end{aligned}$$

This inequality is fulfilled at both skill-levels for $(1-\alpha)^{-1}$ being an even integer.

3.3.4 A Coordination Game with Unobservable Qualification

In the theoretical model by Kirstein and Bleich (2008) agents differ with respect to unobservable qualification, which they choose in the first stage of a three-stage-game by deciding to invest into qualification at cost $K > 0$ or not to invest. After taking part in qualification, agents are high-skilled whereas they remain low-skilled if they do not invest. In contrast to the situation laid out in Section 3.2, cost K are a fixed amount that has to be paid by agents before each of them is randomly matched to one principal. In the second stage, principals screen with respect to qualification, in the third and last stage agents decide to accept or reject a contract offer.

From the agents' investment decisions the fraction b of low-skilled agents in the population results[28]. A principal's optimal contract offer for heterogenous agents is a menu of contracts, that offers a high-skilled agent an information rent that exceeds his outside option and depends on b. Low-skilled agents' payoffs from such an optimal menu are always zero. The higher b, the higher is the information rent and hence the profitability of investing depends on the outcome of the simultaneuos qualification decisions. As there is no means of coordination available, this decision is a coordination problem to the ex ante low-skilled agents in terms of who should invest in productivity.

The information rent in Kirstein and Bleich (2008) (p.6) is: $R^* = \underline{t}^* - 0.5\underline{q}^* = \frac{50b^2}{(1+b)^2}$ with t as a lump-sum transfer and q as the production quantity. It accrues to a high-skilled agent for $b \in [0, 1[$. For b^* to be the equilibrium rate of low-skilled agents in the coordination game, there may not be any incentives for low-skilled as well as for high-skilled agents to deviate from their investment decision. As the number of agents is discrete and every single agent's qualification decision changes the market situation, we set

$$b = \frac{x}{n} \text{ and } R(b) = \frac{50\left(\frac{x}{n}\right)^2}{\left(1 + \frac{x}{n}\right)^2}$$

Where n is the size of the population (the total number of agents) and $x < n$ counts the number of low-skilled agents. By setting the individual incentives to deviate for high- and low-skilled agents to zero, we calculate the equilibrium b^* that fulfills both conditions of no deviation at the same time.

A low-skilled agent does not prefer to be high-skilled under $b = x/n$ if

[28] p from the original text by Kirstein and Bleich (2008) is replaced by b to avoid confusion.

$$\Delta u^I = u(high) - u(low) = \frac{50(x-1)^2}{(n+x-1)^2} - K - 0 \overset{!}{\leq} 0 \tag{3.39}$$

The critical numbers of low-skilled agents are:

$$x_1^I = \frac{K - 50 - n(5\sqrt{2K} - K)}{K - 50}$$

$$x_2^I = \frac{K - 50 + n(5\sqrt{2K} - K)}{K - 50}$$

There is no incentive to become high-skilled for them, if

$$x \in \left[x_2^I, x_1^I\right] \tag{3.40}$$

A high-skilled agent does not regret his investment decision if

$$\Delta u^{II} = u(low) - u(high) = 0 - \frac{50x^2}{(n+x)^2} + K \overset{!}{\leq} 0 \tag{3.41}$$

and thus to him the critical values are:

$$x_1^{II} = \frac{n(-5\sqrt{2K} - K)}{K - 50}$$

$$x_2^{II} = \frac{n(5\sqrt{2K} - K)}{K - 50}$$

Where inequality (3.41) is fulfilled for

$$x \geq x_1^{II} \vee x \leq x_2^{II}$$

Assuming $K < 50$, as for higher values investment into qualification never pays off, we see that $x_2^{II} < 0 < x_1^{II}$. As x represents the number of low-skilled agents in the population, it may not assume negative values. Now we are interested in the values of x that fulfill both inequalities (3.39) and (3.41). This is the intersection of $x \in \left[x_2^I, x_1^I\right]$ and $x \geq x_1^{II}$. If $x_1^{II} < x_2^I$, the equilibrium number of low-skilled agents lies within the boundaries of (3.40):

$$
\begin{aligned}
x_1^{II} &< x_2^{I} \\
\frac{n(-5\sqrt{2K}-K)}{K-50} &< \frac{K-50+n(5\sqrt{2K}-K)}{K-50} \\
K^2-100(1-2n^2)K+2500 &> 0
\end{aligned} \tag{3.42}
$$

The resulting inequality (3.42) is always fulfilled for $n, K \geq 1$. As we are looking for the equilibrium fraction of low-skilled agents b^* in a population of n agents, we now calculate the upper and lower bounds of $b^* = x/n$ depending on K.

$$
b^* \in \left[max\left\{0, \frac{1}{n}+\frac{5\sqrt{2K}-K}{K-50}\right\}; \frac{1}{n}-\frac{5\sqrt{2K}-K}{K-50}\right] \tag{3.43}
$$

The equilibrium fraction of low-skilled agents may only be between zero and one, thus for one of the borders assuming larger or smaller values, b^* becomes 1, respectively 0. The lower bound is smaller than zero for $n > \frac{50-K}{5\sqrt{2K}-K}$, which results in $b^* = 0$, the upper is never larger than one for $0 < K < 50$ and $n > 1$ as $n < \frac{50-K}{50-5\sqrt{2K}}$ is never valid. Hence, all fractions of b that lie within the range stated by (3.43) constitute equilibrium qualification decisions of the agents.

For the experimental treatment $K5$ of Kirstein and Bleich (2008) with $n = 4$ and investment cost of $K = 5$, an investment is profitable, if at least half of the agent population chooses not to invest. If $K > 9$, as e.g. in Treatment $K15$, it is a dominant strategy not to invest, because $\underline{t}^* - 0.5\underline{q}^* \leq 9$ for $b \in [0, 1]$.

Chapter 4

Going on the Long Race

4.1 Long-Term Work Contracts

4.1.1 Introduction

Bewley (1995) and (1998) found in interviews with managers, counselors of the unemployed, labor leaders, and headhunters, that wages do not fall during a recession. He sees the reasons mainly in the employer's fear of the workers' reactions to lower wages which could be less effort or even the declaration of a strike. Agell and Bennmarker (2007) list additional reasons for downward wage rigidities. In their study from 1999 they surveyed swedish managers from five different industrial sectors about the standard theoretical explanations for no downward wage adjustment. They found that efficiency wages as well as the presence of labor unions have a high influence on managers' wage decisions. In that case, very few workers' (1.1%) wages were cut during the prior recession. It is important to note that the workers' expectations do not only refer to their own previous wage but also to the average wage of the person's occupation.

Until the 80s of the 20th century most Germans worked for one employer for their entire life. Dundler and Müller (2006) found evidence that 59% of German male employees born in the 1940s (46% of those born in the 1950s) were employed in their first job for at least 20 years. The years of continuos first employment fall for later birth cohorts. For the 1990s Henneberger and Sousa-Poza (2002) found an increase in job fluctuation from 7.4% in 1992/93 to 10.2% in 1999/2000 for Switzerland. These data show, that nowadays there is much more fluctuation in the labor market. On the one hand, people change occupations to push their career, on the other hand markets have become more flexible and bear more risk than in the mid 20th century. Hence, both employers and employees have reasons to constantly move on rather than staying in the same relationship a worker's entire life. Although job fluctuation increased, most employment is still open-ended. As we can see from Figure 4.1 fixed-term contracts seem to be an exception in the EU on average: In 2007 85.5% of employees worked under open-ended contracts.[1] In Germany this may be due to the Part-Time and Fixed-Term Contract Act (Teilzeit- und Befristungsgesetz), which restricts the conclusion of short-term contracts (§ 14 II TzBfG): Employers are not allowed to contract more than three times with the same worker in short-term contracts within two years. That fixed-term contracts need to be ruled by law shows that there are many firms that like to offer series of short-term contracts to be able to react flexibly to market changes.

There are some differences between EU countries in the last years (2000–2007) with respect to fixed-term contracts: Germany as well as the EU as a whole have a quite stable rate of fixed-term employed workers of 12–14%. In Estonia, starting with 3% in 2000, the fraction of fixed-term workers decreased, in Spain this was also the fact but started at a much higher level of over 30%. These numbers reflect frictions on the respective labor markets. While Germany has a more or less average strict employment protection legislation inside the EU, Spain's strict laws lead employers to offer many fixed-term contracts to circumvent those. The Estonian legislation in contrast allows flexible adjustments of wages and/or employment to react to market fluctuations.

These observations lead to the question, if there is an interdependence between the flexibility of wage adjustment and contract duration. Does higher job fluctuation result from missing possibilities to adjust wages downward in a recession? Or do employers want to cloud falling wages by offering only short-term contracts as they fear workers' efforts to fall?

[1]Data from EuroStat.
[3]Own diagram from EuroStat data.

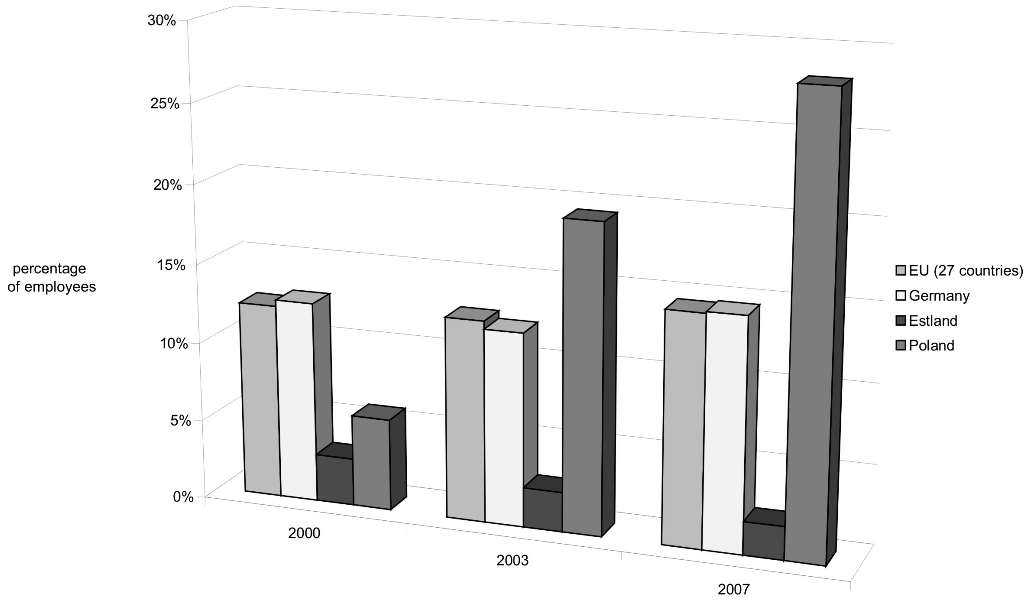


Figure 4.1: Percentage of Fixed-term Employed Employees in the EU and Selected EU Member States[3]

In our experiment we want to test these alternative explanations[4]. The flexibility of a contract is reflected by the adjustment rules to lump sum transfers and piece rates, which are set together with the contract duration by the employer when she offers a contract to a randomly matched worker. Market changes are introduced by a stochastic market wage. The employers' optimal behavior depends in our model on the rules of wage adjustment and the market wage in the period the contract is offered. Workers accept contracts that guarantee them at least their expected utility from the market wage and choose effort depending on the piece rate. Whenever we observe falling wages when market wage falls, effort should, according to Bewley (1998) and Agell and Bennmarker (2007), also decrease.

A theoretical model by Danziger (1988) analyzes a two-period economy with real and nominal shocks: Under inflexible contractual conditions optimal contract duration for workers depends on the probability of a real shock. Nominal

[4]This chapter is an extended version of Berninghaus, Güth, and Bleich (2008).

shocks do not influence optimal choice. If the probability of a real shock is low, the worker prefers two one-period contracts over a two-period contract, as he does not need to be insured against a shock. Although he choses a completely different way to describe the problem, our model yields similar results: Optimal contract duration depends on the flexibility of a contract, allowing an employer to react quickly to exogenous changes.

To our knowledge there is only one experiment on labor contract duration under effort choice and changes in the market wage: ? (?) test wage adjustments in a two-period-world under perfect foresight of a drop in the market wage in the second period. They do observe lower wages in the second period, although employers could have included the change in period two in their first period wage offers. The only labor market experiments with endogenous contract duration are those by Brown, Falk, and Fehr (2004). In contrast to our design, a long-term contract is not concluded by contracting over a previously determined number of periods but when an employer offers another contract to the employee at the end of their contract. We also have this opportunity but both contract partners need to agree to be matched again. What is more, the market wage is fixed in their experiments. What Brown et al. (2004) observe is the profitability of long-term contracts under incomplete contracts. In our setting this is only the case where employers are able to sanction shirking workers. Both profit from long-term contracts due to effort smoothing and avoiding market risk. Anderhub, Königstein, and Kübler (2003) also ran experiments with endogenous long-term labor contracts, but the authors' focus lay on firm-specific investments by agents.

The following section describes the theoretical model that underlies the experiment and its solution. In section 4.2 the experimental parameters and the statistical analysis of experimental results are given. In section 4.3 a conclusion follows.

4.1.2 The Theoretical Model

4.1.2.1 Fixed Wage Flexibility and Effort Choice

With a finite number of T periods, workers and employers meet one by one. The number of employers and workers is equal. That means there is neither competition for jobs nor for workers. Each employer offers an employment contract $\sigma = (w; s; \tau)$ to one worker. The contract consists of a fixed wage $w \geq 0$, a piece rate $s \in [0, 1]$ and the contract duration $\tau \geq 0$. Workers are credit constrained. If the respective worker accepts the offered contract, he chooses his effort level e. If no contract is concluded, both are matched with new partners in the next period. The worker is assumed to be risk neutral and his utility from a contract is

$$U = w + P \cdot s \cdot e - \frac{c}{2}e^2.$$

Effort directly converts into output units, which are sold at the fixed price P. The piece rate ($s \in [0, 1]$) is a division rule and divides the sales revenue ($P \cdot e$) between employer and worker. $c > 0$ is equal for all workers. The employer's gain from a contract is

$$\Pi = P(1 - s)e - w.$$

If the worker does not accept the contract, he is employed at the market wage w^c, which is positive and randomly drawn from a uniform distribution with known limits each period anew ($w^c \in [\underline{w}^c, \overline{w}^c]$). The employer gets zero profit. There is no information about future market wages. Also during a long-term contract ($\tau > 1$) there is a new market wage in each period.

We look at different rules of wage adjustment inside of a long-term contract, from completely fixed to totally flexible wages. The applying rules of adjustment for an employer are assigned to five different experimental treatments and will be described in the following section. As the worker chooses effort in each period, he is able to react to changes. There is no possibility to terminate an employer-employee relationship before the end of the contracted duration.

4.1.2.2 Rules of Wage Adjustment in the Experiment

As we want to look at wage rigidities under different flexibility regimes, we introduce five different experimental treatments; in each of them contract duration can never be changed.

- **N**o flexibility: In a long-term contract fixed wage and piece rate cannot be adjusted.

- **P**artial **U**pward flexibility: The employer can raise the fixed wage over the wage of the previous contract period. The contracted piece rate is fixed.
- **U**pward flexibility: Fixed wage and piece rate can be increased by the employer during a long-term contract.
- **P**artial **T**otal flexibility: The fixed wage can be varied freely ($w \geq 0$) by the employer. The contracted piece rate is fixed.
- **T**otal flexibility: Fixed wage and piece rate can be set anew ($w \geq 0$, $s \in [0, 1]$) in each period of a long-term contract.

The only possibility to react to a wage change for workers is to adjust effort. A concluded contract cannot be canceled. In treatments N, PU and U we expect employers to offer mainly short-term contracts (one period) to keep the possibility to react to changes in the market wage, which then represent the workers' outside option. Workers are expected to exert less effort as even in long-term contracts there is no possibility for employers to fine them by decreasing wages. Employers and workers are not identifiable, hence there is also no reputation building. Treatments PT and T have no rules of fixed wage adjustment. In this case employers do not incur any risk by offering long-term contracts as they can also adjust to falls in the market wage. Workers should exert higher effort as they may be fined by their employer for shirking.

At the end of each contract, employer and worker are asked whether they want to interact again with the same partner or want to be randomly matched to a free other player (random stranger matching). This is done to give the opportunity to conclude a series of short-term contracts which, according to results by Antoni and Jahn (2006), may be a reason for falling contract durations in the German labor market.

4.1.3 Theoretical Analysis

At first, the situation of a new contract offer in the last period is discussed. The employer-worker-pair is either a random new match or both wanted to be matched again with the same partner. It is important to note, that in this situation the fixed wage as well as the piece rate can be set freely as there is no downward boundary from earlier periods. This solution also applies to all other periods with new contracts if players are myopic. Secondly, we look at earlier periods and rationalize the conclusion of long-term contracts for some treatments.

4.1.3.1 Behavior in the Last Period

In the last period the employer can only offer a one-period contract. We solve the employer's problem to choose a contract by applying backward induction. The last decision is the worker's effort choice, depending on the piece rate, which is maximizing his utility:

$$\max_e \; U(e) = \max_e \; w + Pse - \frac{c}{2}e^2$$

$$\begin{aligned} \frac{\partial U(e)}{\partial e} &= Ps - ce \stackrel{!}{=} 0 \\ e^* &= \frac{Ps}{c} \end{aligned} \tag{4.1}$$

This choice gives the worker a utility of

$$U(e^*) = w + \frac{(Ps)^2}{2c}.$$

His outside-option is the market wage w^c. The employer takes the worker's outside-option and his optimal choice of effort e^* into account, when maximizing her gain from an accepted contract. So the employer maximizes her gain by choosing wages:

$$\max_{s,w} \; \Pi(s,w) = \max_{s,w} \; (1-s)s\frac{P^2}{c} - w$$

subject to

$$w^c \leq w + \frac{(Ps)^2}{2c} \tag{4.2}$$

As the employer is in the position to make a take-it-or-leave-it offer, she sets the side condition to an equality, introduces it into $\Pi(s, w)$ and maximizes over the choice of s, hence we have:

$$\begin{aligned} \frac{\partial \Pi(s)}{\partial s} &= \frac{P^2(1-s)}{c} \stackrel{!}{=} 0 \\ s^* &= 1 \end{aligned} \tag{4.3}$$

The optimal piece rate leaves all the sales revenue to the worker. This situation is efficient, because the worker exerts the highest effort. The optimal fixed wage is $w^* = w^c - \frac{P^2}{2c}$. In the experiment we chose parameters $P = 10$, $c = 1$ and $w^c \in \{13, 14, ..., 30\}$. For these values $w^* = w^c - 50$, which cannot be positive. As we only allow non-negative wage offers, the profit maximizing contract cannot be offered by the employer. If she offered instead $s = 1$ and $w = 0$, the worker would accept the contract, as it would give him $U(s = 1, w = 0) = 50$, which is more than w^c, but the employer would have zero gain. The employer sets the fixed wage to zero ($w^{*;SB} = 0$) and chooses s to fulfill the worker's outside option. This results in:

$$s^{*;SB} = \frac{1}{P}\sqrt{2c \cdot w^c}.$$

The worker accepts the second best contract $\sigma^{*;SB} = (0; \frac{1}{P}\sqrt{2c \cdot w^c}; 1)$ as it pays him the market wage. The employer's profit from this contract is $\Pi(s^{*;SB}) = \frac{P}{c}\sqrt{2c \cdot w^c} - 2w^c$, which is positive for our experimental parameters. The worker exerts effort $e^{*;SB} = \frac{1}{c}\sqrt{2c \cdot w^c}$.

The second best contract in the last period/for myopic players is short-term, so there are no differences between treatments. The situation where myopic players are in a long-term contract with an already downward bounded fixed wage, does not occur (theoretically) as for this type of players there is no incentive to conclude long-term contracts.

4.1.3.2 Finitely Repeated Interaction

In all other periods employers could offer contracts with a longer duration. If the profit from long-term contracts is higher than from offering a series of short-term contracts, no short-term contracts will be offered. With τ as the offered contract duration and without depreciation, the worker's expected utility in the offer period t and all future periods can be stated as:

$$U_t^{out} = w_t^c + (\tau - 1)\frac{\underline{w}^c + \overline{w}^c}{2}$$

with $\underline{w}^c$ and $\overline{w}^c$ representing the lower and upper bounds to the uniformly distributed market wage. U_t^{out} is the outside option of a farsighted worker in period t. As the worker will always be in the position to accept or reject a take-it-or-leave-it offer, employers will set him to his outside option, which is the market wage. In a long-term contract the employer has to pay a piece rate and/or a fixed wage to set the worker indifferent between his outside option and accepting the offered contract. At first, we look at situations with a downward fixed piece rate (treatments N, PU, PT and U). Here the piece rate is guaranteed for the contract's duration. The employer takes into account the worker's optimal choice of effort $e^* = \frac{Ps}{c}$ and sets the worker's expected utility from the long-term contract equal to his outside option:

$$\begin{aligned} \tau \cdot \left[P\hat{s} \cdot \frac{P\hat{s}}{c} - \frac{c}{2} \cdot \left(\frac{P\hat{s}}{c}\right)^2\right] &= U_t^{out} \\ \hat{s} &= \frac{1}{P} \cdot \sqrt{\frac{U_t^{out} \cdot 2c}{\tau}} \end{aligned} \tag{4.4}$$

With this piece rate $\hat{s}$ and a zero fixed wage, the worker is indifferent between the outside option and the offered long-term contract $\hat{\sigma} = (0, \hat{s}, \tau)$ which gives to the employer $\hat{\Pi} = \frac{P}{c}\sqrt{\frac{U_t^{out} \cdot 2c}{\tau}} - \frac{2U_t^{out}}{\tau}$. The employer's alternative to offering $\hat{\sigma} = (0; \hat{s}; \tau)$ is to offer τ 1-period-contracts in a row.

These contracts would be written according to the rules of the previous section, $\sigma^{*;SB} = (0; \frac{1}{P}\sqrt{2c \cdot w^c}; 1)$, starting in period t:

$$
\begin{aligned}
\tau \cdot \hat{\Pi}_t &> \Pi_t^{*;SB} + \sum_{n=t+1}^{\tau+t} E(\Pi_n^{*;SB}) \\
\tau \frac{P}{c}\sqrt{\frac{2c \cdot U_t^{out}}{\tau}} - 2 \cdot U_t^{out} &> \frac{P\sqrt{2c \cdot w_t^c}}{c} - 2w_t^c \\
&\quad + E\left(\sum_{n=t+1}^{\tau+t}\left[\frac{P\sqrt{2c \cdot w_n^c}}{c} - 2 \cdot w_n^c\right]\right) \\
\tau \frac{P}{c}\sqrt{2c}\sqrt{\frac{U_t^{out}}{\tau}} - 2 \cdot U_t^{out} &> \frac{P\sqrt{2c \cdot w_t^c}}{c} \\
&\quad + E\left(\sum_{n=t+1}^{\tau+t}\frac{P\sqrt{2c \cdot w_n^c}}{c}\right) - 2w_t^c - 2E\left(\sum_{n=t+1}^{\tau+t} w_n^c\right) \\
\tau \frac{P}{c}\sqrt{2c}\sqrt{\frac{U_t^{out}}{\tau}} - 2 \cdot U_t^{out} &> \frac{P\sqrt{2c \cdot w_t^c}}{c} + \frac{P\sqrt{2c}}{c} \cdot E\left(\sum_{n=t+1}^{\tau+t}\sqrt{w_n^c}\right) \\
&\quad -2w_t^c - 2(\tau-1)\frac{\underline{w}^m + \overline{w}^m}{2} \\
\tau \frac{P}{c}\sqrt{2c}\sqrt{\frac{U_t^{out}}{\tau}} - 2 \cdot U_t^{out} &> \frac{P}{c}\sqrt{2c}\left[\sqrt{w_t^c} + (\tau-1)E(\sqrt{w_t^c})\right] - 2 \cdot U_t^{out} \\
\sqrt{\tau \cdot U^{out}} &> \sqrt{w_t^c} + (\tau-1)E(\sqrt{w_t^c})
\end{aligned}
$$

Here, the expected piece rate of a one period contract depending on all possible market wages that realize with equal probabilities is

$$
E(\sqrt{w_t^c}) = \frac{\sum_{i=\underline{w}^m}^{\overline{w}^m}\sqrt{i}}{\sharp(\text{poss. market wages})}.
$$

With our experimental parameters the inequality that dictates the employer's decision becomes:

$$
g(w_t^c, \tau) = \tau\sqrt{\frac{w_t^c + 21.5(\tau-1)}{\tau}} - \sqrt{w_t^c} - (\tau-1) \cdot 4.6 > 0
$$

$g(w_t^c, \tau)$ is always positive which can be seen from Figure 4.2. The employer offers only long-term contracts $\hat{\sigma} = (0; \hat{s}; \tau)$ with the maximum duration, as her profit from effort smoothing is higher than from offering a series of short-term contracts $\sigma^{*;SB}$ and increases with the number of contract periods.

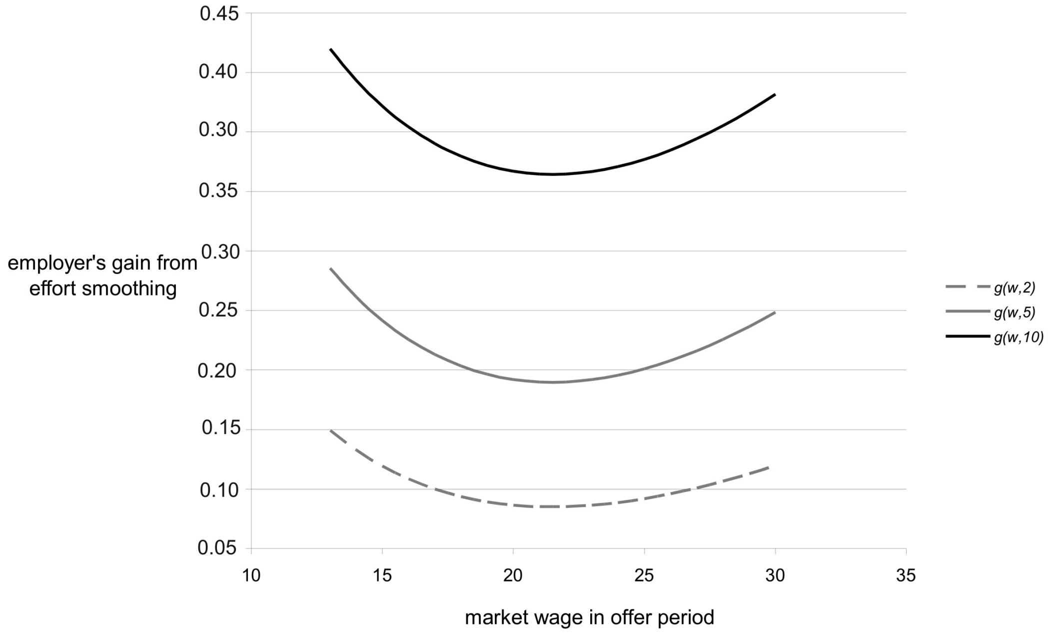


Figure 4.2: Employer's Gain from Effort-smoothing for Different Contract Durations and Market Wages in the Offer Period

In the next section, we look at a situation with fully flexible piece rates during an existing contract. With some rigidities to wage adjustment, the employer has to take into account the worker's outside option of working at the market wage. But if a worker once is locked into a long-term contract, the employer may now exploit this situation and set the piece rate freely. Thus, it is necessary to look at that situation separately.

4.1.3.3 Piece Rate Flexibility

In treatment T of our experiment the fixed wage as well as the piece rate can be set anew each period during a contractual relationship by the employer. That means, during a contract the piece rate can also be decreased. With the acceptance of a long-term contract the worker looses his outside option of getting the market wage and is subject to the employer's goodwill.

We solve the employer's problem by applying backward induction. In the final period τ of a long-term contract the emloyer is able to change fixed wage and piece rate without any side conditions except non-negativity. She maximizes:

$$\max_{s_\tau} \; -w_\tau + (1-s_\tau)s_\tau \frac{P^2}{c}$$

and sets the optimal piece rate $s^*_\tau = 0.5$. She is able to do this, irrespective of the actual market wage because the worker's outside option at this time is zero as he cannot quit the contract. The fixed wage is only a transfer to the worker and can be set to $w^*_\tau = 0$. This kind of reasoning applies to all earlier contract periods except the offer period, where the positive expected outside option of the worker (U^{out}_t) has to be taken into account. The worker's utility from a long-term contract becomes:

$$U(w_1, s_1, w^*_\tau, s^*_\tau, \tau) = w_1 + \frac{(Ps_1)^2}{2c} + (\tau-1)\cdot\left[w^*_\tau + \frac{(Ps^*_\tau)^2}{2c}\right].$$

This has to be at least equal to the worker's outside option and becomes the side condition of the employer's maximization problem in each period she offers a contract. Thus the employer maximizes her gain

$$\Pi(w_1, s_1) = -w_1 + (1-s_1)s_1\frac{P^2}{c} + (\tau-1)\left[-w^*_\tau + (1-s^*_\tau)\cdot s^*_\tau\frac{P^2}{c}\right]$$

presuming optimal behavior of the worker. The employer's contract offer results from:

$$\max_{w_1, s_1} \Pi(w_1, s_1) \tag{4.5}$$

subject to

$$w_1 + \frac{(Ps_1)^2}{2c} + (\tau-1)\cdot\left[w^*_\tau + \frac{(Ps^*_\tau)^2}{2c}\right] \geq U^{out}_t$$

As the employer makes a take-it-or-leave-it offer to the worker, she sets the side condition to an equality. After solving the side condition for s_1, it is introduced into the employer's yield function, which is then maximized over w_1. We get a fixed wage for the contract offer period of:

$$w_1^* = U_t^{out} - (\tau - 1)\frac{p^2}{4c}.$$

If we plug this into the side condition of (4.5) we get a piece rate of $s_1^* = 0$. The expected value of the employer's gain is $E(\Pi_1^*) = -U_t^{out}$, which is negative. Consequently, this contract will not be offered. But making use of the argument that a fixed wage does not have an influence on the worker's effort, she sets the minimum possible fixed wage of zero $w_1^{SB} = 0$ also in the offer period and solves the side condition of (4.5) for s_1. The first period piece rate of a long-term contract under fully flexible wages with $s_\tau^* = 0.5$ and $w_\tau^* = 0$ thus is:

$$s_1^{SB} = \sqrt{\frac{2c}{P^2}U_t^{out} - \frac{1}{4}(\tau - 1)}.$$

This contract constitutes again a second-best solution to the employer. Depending on the market wage in the offer period w_t^c this contract cannot be offered for all possible contract durations as for certain combinations s_1^{SB} becomes larger than unity. With the experimental parameters[5], we may not accept contract durations longer than $\tau = 6$. The employer's profit from such a contract is:

$$\Pi_1^{SB} = s_1^{SB}(1 - s_1^{SB})\frac{P^2}{c} + (\tau - 1)s_\tau^*(1 - s_\tau^*)\frac{P^2}{c}.$$

An employee is in expectancy indifferent between the long-term contract and a series of one-period contracts. But does it pay off for an employer to offer a long-term contract? We need to compare the employer's profit from a long-term contract σ_1^{SB} of length τ with his profit from offering a series of τ short-term contracts $\sigma^{*;SB}$ to answer this question. If we make the same assumptions as in section 4.1.3.2 for our experimental parameters the decision about which contract to offer again depends on contract duration and the market wage in the offer period. The inequality

$$\Pi_1^{SB} \geq \Pi_t^{*;SB} + \sum_{n=t+1}^{\tau+t} E\left(\Pi_n^{*;SB}\right)$$

[5] $w_n^c \in \{13, 14, ..., 30\}$; $c = 1$; $P = 10$; $T = 10$.

becomes:

$$\frac{\sqrt{2}P}{\sqrt{c}}\left(\sqrt{U_t^{out}-(\tau-1)\frac{P^2}{8c}}-\sqrt{w_t^c}-(\tau-1)E(\sqrt{w_t^c})\right)+(\tau-1)\frac{P^2}{2c}\geq 0.$$

It can be solved for w_t^c but then becomes very elaborate and does not give any insights about how the combinations of w_t^c and τ have an influence on the employer's decision between short- and long-term contracts. Thus we look at it in the regions of w_t^c and τ that are relevant for our experiments. For

$$w_t^c \leq 22.65+\tau(0.28\cdot\tau-5.07)$$

the employer would prefer a long-term contract over a series of short-term contracts[6]. That means, she only wants to offer a long-term contract for a market wage in the offer period of $w_t^c = 13$ that would last for two periods: $\sigma_1^{SB} = (0; 0.66; 2)$. In all other cases, the short-term contract is preferred.

For all infeasible combinations, the employer may have the possibility to offer a first-period contract with positive lump sum payment that is accepted by the worker *and* is preferred over a series of short-term contracts. As this kind of contract offer does not result from any profit- or utility-maximizing rationale, it is not further analyzed.

We did not analyze all possible combinations of wage adjustment, on one hand, we did not look at those in our experiments either, on the other, because from a theoretical view their solution depends on the flexibility of the piece rate, thus a situation with inflexible fixed wages and upward or full flexibility of piece rates lead to the same results as were described here respectively.

4.2 Contract Duration Experiments

The experiment was conducted at the University of Karlsruhe[7]. The subject pool consists of students of different faculties. For treatments PU and PT we had eleven sessions, for treatments N, U and T we had six sessions each. The

[6] Values on the right hand side are rounded.

[7] The experiment was run by means of the Deutsche Forschungsgemeinschaft.

software was developed at the University of Karlsruhe (Institute WiOR), it was set in discrete time. Each session lasted for ten periods with fixed roles of employers and workers. That results in 400 participants in the experiment.[8] In Table 4.1 the participants' average payoff in Euro is given:

Table 4.1: Participants' Average Payoffs for All Treatments (Euro)

	N	PU	U	PT	T
employer	18.14	14.98	13.88	13.79	18.55
employee	18.11	20.13	19.17	18.94	18.71
average	18.12	17.03	16.52	16.38	18.63

In each matching group there were five employers and five workers. In every period participants with no given partner from an already existing contract were randomly matched within their matching group of ten and the random and uniformly distributed market wage was announced. Free employers offered a contract to the worker they were matched with. This contract was accepted or declined by the worker. If accepted, the worker chose his effort for this period, if declined the worker got the market wage and the employer was left with nothing. Own results and those of their partner in the respective period were shown to participants at the end of each period and could be recalled on the screen at any time. After all participants had made their decisions, the next period started.

For our experimental parameters[9] the optimal terms of contract with myopic players are:

$$\sigma^{*;SB} = (0; 0.1 \cdot \sqrt{2w_t^c}; 1).$$

For farsighted employers in treatments PU, U, N and PT it is optimal to offer contracts with the maximum possible duration (τ_{max}), which are accepted by workers:

$$\hat{\sigma} = \left(0; 0.1 \cdot \sqrt{\frac{2w_t^c + (\tau_{max} - 1)43}{\tau_{max}}}; \tau_{max}\right).$$

[8] Two one period contracts one from treatment PU and one from T are excluded from the sample as workers chose the internal upper limit of effort (499). As this choice led to detrimental losses we consider it as a fault by the participants.

[9] $w_n^c \in \{13, 14, ..., 30\}$; $c = 1$; $P = 10$; $T = 10$.

In the treatment with full flexibility (T), the employer prefers under a market wage of $w_t^c = 13$ to offer a two-period-contract with

$$\sigma_1^{SB} = (0; 0.66; 2) .$$

For higher market wages, she offers short-term contracts $\sigma^{*;SB}$. The contracts should be accepted by workers and lead to an effort of $e^* = 10 \cdot s$.

4.2.1 Experimental Results

In Table 4.2 a description of the experimental variables' averages is displayed. All averages except from effort are calculated for the periods in which a new contract was offered. This is done to keep treatments with different rules of wage adjustment comparable. Effort is averaged over all effort decision periods of workers, periods with rejected contracts are omitted in that case. As the market wage is random and not all periods are considered, its average is also shown for all treatments.

Table 4.2: Average Experimental Results for All Treatments

	N	PU	U	PT	T
market wage	21.712	22.119	21.890	20.917	20.096
fixed wage	13.039	11.449	9.667	12.075	11.718
piece rate	0.493	0.532	0.534	0.523	0.541
accepted [%]	72.0	73.1	76.8	70.7	71.8
offered duration	1.311	1.539	1.430	1.737	1.973
effort	8.000	6.466	6.506	6.568	7.695

The acceptance rate is highest for treatment U which gives workers maximum insurance with an option to improve. Employers on average offer the lowest contract duration with no flexibility (N) and highest with full flexibility (T). All average efforts are higher than $\hat{e} = 10 \cdot s$ predicts. Although workers are not in fear of a wage reduction in treatment N, their effort is on average highest for this treatment followed by T. Average piece rates are all near 0.5, which most probably served as a focal point.

4.2.1.1 Offered Contract Duration

Due to the results of Section 4.1.3.2 in treatments N, PU, U and PT long-term contracts $\hat{\sigma}$ are offered in all periods $t \leq 9$. In treatment T $\sigma_1^{SB} = (0; 0.66; 2)$ is offered whenever the market wage is at its lowest possible level for $t \leq 9$. With higher market wages, a short-term contract $\sigma^{*;SB}$ should be offered. This leads to the hypothesis:

> H_1A: Offered contract duration does not differ from optimal duration.

We test H_1A by applying Sign-Tests to compare offered contract duration with maximal contract duration, which is $10-t+1$ and with short-term contracts. Wherefore we keep comparability, although the theoretical solutions vary over treatments.

Table 4.3: Offered Contract Duration in Treatments

	N	PU	U	PT	T
avg. offered duration	1.311	1.539	1.430	1.737	1.973
avg. maximal duration	5.498	5.468	5.536	5.637	5.878
avg. optimal duration	=	=	=	=	1.138
Sign-T. one-period (P)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sign-T. max. duration (P)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sign-T. opt. duration (P)	=	=	=	=	=

As can be seen from Table 4.3, offered contract duration differs significantly from average maximal duration as well as from one-period contracts. Employers' contract offers lie between minimal and maximal duration except for treatment T, where the average optimal duration is 1.138 (26 two-period- and 162 one-period contracts). Also if we divide the samples into the first and second five periods the picture stays the same. Further analysis shows that offered contract duration is significantly shorter than possible. Recall that due to effort-smoothing longer contract durations should be preferred in all treatments but T. This leads to the results:

Result A *Participants in all treatments offered significantly different contract durations than expected, with on average shorter contracts than possible. H_1A cannot be supported.*

If we compare between treatments, offered contract duration in treatment T should be shorter than in all other treatments (compare $\hat{\sigma}$ and σ_1^{SB}). A behavioural interpretation of the average offered contract duration would be that employers try to bind workers to establish a situation of reciprocity. In treatments PT and T the employer can directly react to the worker's effort choice in a long-term contract. In other treatments the thread of punishment is missing. Ergo, if the behavioural reasoning applies, offered contract duration is higher in treatments PT and T than in N, PU and U. For building our hypothesis, we stick to the theoretical solution:

H_1B: Offered contract duration in treatment T is shorter than in the other treatments.

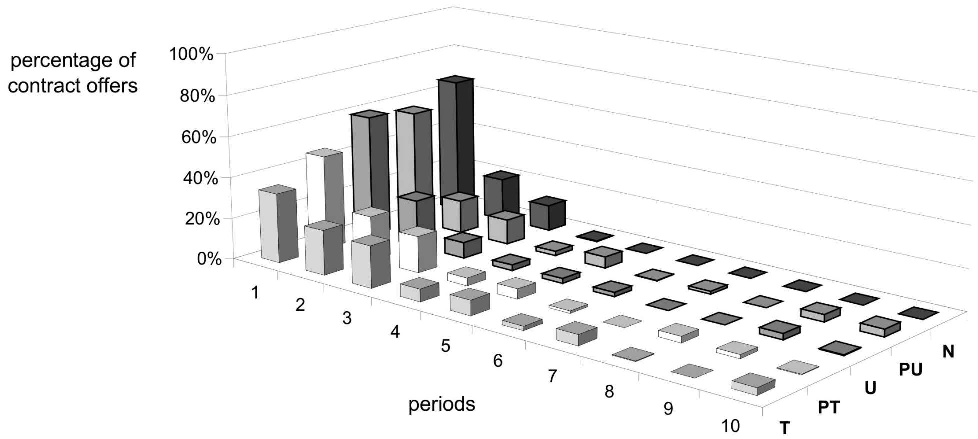


Figure 4.3: Offered Contract Duration for all Treatments

To get an overview of the offered duration in all treatments see Figure 4.3. The fraction of one-period contracts is higher, the less flexible the terms of contract are. To test H_1B, we apply a Kruskal-Wallis One-Way ANOVA on ranks to see if there is a significant difference between treatments regarding offered contract duration. Although averages are quite similar, the difference is highly significant (H=51.136; P$<$ 0.001). To isolate the treatments which are causing the difference, we compare pairwise using Dunn's Method (Table 4.4). The values of the test variable Q indicate significant differences between treatments T respective PT and all other treatments. There is no significant difference between offered contract duration in all other treatments, also PT and T do not differ. Figure 4.3 visualizes the differences: Most contract offers lie in the range between one and three periods, but in treatments U, PU and N there are fewer two and three period contracts and more one-period offers. We also see that employers by far do not offer durations over the whole available range.

Table 4.4: Results of Dunn's Test on Correlation of Offered Contract Duration Between Treatments

	N	PU	U	PT	T
N		no	-	yes	yes
PU	no		-	yes	yes
U	-	-		yes	yes
PT	yes	yes	yes		no
T	yes	yes	yes	no	

RESULT B *Offered contract duration is significantly different from the other treatments in PT and T. H_1B cannot be supported: Employers want to bind workers if they can negatively reciprocate to effort reductions.*

4.2.1.2 Wages Offered

The optimal offered piece rate should depend on the market wage of the actual period and the offered contract duration. We look at the optimality of piece rate offers in one-period and long-term contracts separately.

H_1C: In treatments N, PU, U and PT employers offer in long-term contracts the optimal piece rate of

$$s^{+} = \frac{1}{10} \cdot \sqrt{\frac{2w_n^c + 43 \cdot (\tau - 1)}{\tau}}.$$

In treatment T they offer under $w_t^c = 13$ two-period contracts with

$$s_1^{SB} = 0.66.$$

In one-period contracts

$$s^{*;SB} = \frac{1}{10} \cdot \sqrt{2w_n^c}$$

is offered in all treatments.

As the optimal piece rate depends on contract duration and the market wage of the offer-period, we have paired samples of actual and optimal piece rates. For treatment T, contracts with suboptimal contract duration are excluded from this analysis as for these there is no theoretical prediction for the piece rate (i.e., we excluded 89 of 188 contract offers of treatment T). The Sign-Test finds significant differences (all P-Values < 0.001) for all treatments. Also the contract offers of one period differ significantly from the optimal behavior of a myopic employer. As already mentioned, participants seem to take fixed wages into account and seem to compensate low piece rates by higher than optimal fixed wage offers. The following can be stated:

RESULT C *Offered piece rates are significantly different from optimal ones.*

As we saw in Table 4.2 all averages of offered fixed wages are strictly greater than zero, which differs from the prediction of zero fixed wages. The percentages of zero fixed wage offers are: N (12.5%), PU (18.0%), U (20.7%), PT (13.5%), and T (17.6%). They seem to be independent of the degree of flexibility. Offered fixed wages differ according to a Kruskal-Wallis ANOVA over treatments, but as percentages of zero offers suggest, only treatments N and U actually differ significantly. As piece rates are also higher than expected, positive fixed wages cannot be explained by the theoretical model.

4.2.1.3 Acceptance of Contract Offers

After analyzing the optimality of contract offers, we look at the quality of contract acceptance decisions. Workers should accept contracts that lead to an (expected) utility at least as high as the (expected) market wage. To compare expected utility from a contract with the expected market wage in long-term relationships, we calculate expected utility from a contract assuming an optimal effort choice by workers. We also take into account the different rules of wage adjustment of the different treatments. In the following table, the equations for expected utility from a contract are given. We calculated these assuming that employers would not increase their wage offers even if they could, i.e. fixed wages fall to zero if possible and the piece rate is set to 0.5.

Table 4.5: Expected Utility from a Long-term Contract

treatment	expected utility
N	$\tau(w + 50s^2)$
PU	$\tau(w + 50s^2)$
U	$\tau(w + 50s^2)$
PT	$w + \tau 50s^2$
T	$w + 50s^2 + (\tau - 1)12.5$

H_0D: Workers' contract acceptance does not differ from optimal acceptances.

Workers' contract acceptances differ significantly from optimal acceptance for all treatments except PT, where a nearly equal number of contracts is wrongly accepted and rejected. This also results in the best match between the percentages of accepted contracts. Test results are summarized in the next result:

Result D

	N	PU	U	PT	T
actual acceptance [%]	72.0	73.1	76.8	70.7	71.8
optimal acceptance [%]	87.5	88.8	89.9	69.2	62.8
P-Value(Sign-Test)	< 0.001	< 0.001	< 0.001	0.2451	0.011

These numbers also imply that for treatments N, PU and U nearly 90% of contract offers were acceptable for workers. Nevertheless, in all treatments only between 70% and 77% of the offers were accepted, which better suits in treatments PT and T. An explanation of this behavior could be that workers did not want to engage in long-term contracts in treatments where employers have the possibility for downward adjustment of (the) wage(s).

To get a closer view of the factors that influence the workers' decision to accept, we ran Logit-regressions of contract acceptance on various potential determinants. The results can be found in Table 4.6. We are regressing on the probability to accept a contract. Besides, the terms of the contract (offered duration, fixed wage and piece rate) as well as the prevailing market wage and the relationship's status (new random match or renewed relationship) may have an influence on the decision. We also included treatment dummies to account for different rules of adjustment and the offer period to see if there is learning. The first entry of each cell represents β, the number in brackets is the according standard deviation and the term in italics shows the P-value. If we exclude the insignificant independent variables, the constant also becomes insignificant, but we can determine the terms of contract, as well as the market wage and the relationship's status as determinants of the probability to accept a contract.

The highest positive influence has the piece rate ($\beta_{piece} = 8.433$), followed by the fixed wage, all other significant independent variables seem to deter the worker from accepting. The longer the offered contract and the higher the market wage, the lower the probability to accept. $\beta_{newcontract}$ shows that workers have a lower probability to accept a contract if the employer is randomly matched, which means that we observe some kind of trust in already known partners.

Table 4.6: Logit Regression of Contract Acceptance β (Std.Dev.) *P-Value*

	1	2	3	4
constant	-0.909 (0.459)	-0.779 (0.428)	-0.842 (0.439)	-0.723 (0.408)
	0.047	*0.069*	*0.055*	*0.077*
offered duration	-0.461 (0.062)	-0.467 (0.062)	-0.468 (0.062)	-0.473 (0.062)
	<0.001	*<0.001*	*<0.001*	*<0.001*
fixed wage	0.163 (0.015)	0.162 (0.014)	0.162 (0.015)	0.161 (0.014)
	<0.001	*<0.001*	*<0.001*	*<0.001*
piece rate	8.410 (0.705)	8.424 (0.705)	8.421 (0.707)	8.433 (0.707)
	<0.001	*<0.001*	*<0.001*	*<0.001*
new contract	-0.752 (0.162)	-0.770 (0.161)	-0.762 (0.162)	-0.779 (0.160)
	<0.001	*<0.001*	*<0.001*	*<0.001*
market wage	-0.143 (0.016)	-0.143 (0.016)	-0.141 (0.016)	-0.141 (0.016)
	<0.001	*<0.001*	*<0.001*	*<0.001*
PU	0.129 (0.202)	0.125 (0.202)	–	–
	0.523	*0.537*		
U	0.376 (0.232)	0.370 (0.231)	–	–
	0.104	*0.110*		
PT	-0.059 (0.200)	-0.064 (0.200)	–	–
	0.767	*0.748*		
T	0.030 (0.247)	0.028 (0.247)	–	–
	0.904	*0.910*		
period	0.019 (0.024)	–	0.018 (0.024)	–
	0.429		*0.456*	
Likelihood Ratio	337.159	336.532	332.342	331.786
P-Value	<0.001	<0.001	<0.001	<0.001

To go in more detail, we want to see whether the acceptance rate of long term contracts is higher in treatments with stricter rules of adjustment with respect to the piece rate. This leads to the hypothesis that for treatments N, PU and U the acceptance rate of long term contracts is higher than for treatments PT and T.

> H_1E: The acceptance rate of long-term contracts differs over treatments.

A χ^2-test shows that there is no significant difference in acceptance behavior of workers between treatments. We state:

> RESULT E *Workers' contract acceptance of long-term contracts cannot be explained by fear of being exploited by the employer, as acceptance behavior does not differ over treatments.*

This also supports our regression results that there is no influence by the treatment on the workers' contract acceptance decision.

4.2.1.4 Effort Choice

After accepting a contract, workers choose effort. Their choice is limited to positive values. We excluded effort choices that led to a negative payoff for the worker as we consider these as mistakes. The second row of Table 4.7 gives the percentage of effort choices for each treatment which is left unconsidered. The small numbers show that nearly the whole sample remains included. The third row shows the percentage of workers who account for negative payoffs. If a worker chooses his effort optimally it is $10 \cdot s$ and does not react on changes in the fixed wage. Thence, the next hypothesis is:

> H_0F: Workers choose effort optimally.

All workers' effort choices are compared pairwise by applying a Sign-Test to the data of each treatment separately with the optimal effort in the respective period, which is determined by the piece rate.

Table 4.7: Effort Choice

	N	PU	U	PT	T
number of observations	228	438	245	433	246
% with neg. payoff	3.1	2.1	1.6	1.2	2.0
% of workers with neg. payoff	20.0	14.5	10	9.1	16.7
actual effort	5.226	5.928	5.523	6.189	5.780
optimal effort	5.119	5.373	5.353	5.468	5.499
Pearson Product-Moment Corr.	0.833	0.589	0.797	0.590	0.707
P-Value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sign-Test (P-Value)	0.360	< 0.001	0.0013	< 0.001	< 0.001

As can be seen from the Pearson Product-Moment correlations in Table 4.7, the correlation between actual and optimal effort choice is positive and highly significant. The Sign-test results show that for all treatments, except N there is a significant difference in the distribution of actual and optimal effort, workers exert more effort than optimal. So we can state:

> Result F *Workers' effort choice in treatment N is near optimal choice. In the other treatments workers exert higher effort than optimal. H_1F cannot be supported, except for treatment N.*

To see how workers determine their effort we ran regressions of effort on various parameters that describe the worker's situation. The results can be found in Table 4.8.

Both wages have a significantly positive influence on the workers' effort decision. There seems to be some kind of learning: As shown in Table 4.7, workers exert higher effort than optimal but here we find a negative time trend, which means that the high efforts seem to result from earlier periods of the game. We included a last contract period dummy to isolate end-game effects, but they do not seem to occur as well as the effort decision is not influenced by the market wage, which could serve as a reference wage. The only treatment-dummy that is significant in the first regression becomes insignificant after excluding the afore mentioned variables. This result is not surprising as effort choice depends op-

Table 4.8: Multiple Linear Regression of Effort β (Std.Dev.) *P-Value*

	1	2	3
constant	4.883 (1.836)	4.973 (1.529)	3.951 (1.388)
	0.008	*0.001*	*0.004*
fixed wage	0.059 (0.028)	0.066 (0.027)	0.063 (0.026)
	0.037	*0.013*	*0.016*
piece rate	8.184 (1.958)	8.434 (1.905)	8.193 (1.900)
	<0.001	*<0.001*	*<0.001*
period	-0.398 (0.104)	-0.407 (0.103)	-0.412 (0.103)
	<0.001	*<0.001*	*<0.001*
PU	-1.839 (0.925)	-1.801 (0.921)	–
	0.047	*0.051*	
U	-1.560 (1.038)	-1.520 (1.036)	–
	0.133	*0.143*	
PT	-1.565 (0.932)	-1.515 (0.923)	–
	0.093	*0.101*	
T	-0.521 (1.056)	-0.463 (1.036)	–
	0.622	*0.655*	
market wage	0.027 (0.056)	–	–
	0.629		
last contract period dummy	-0.389 (0.655)	–	–
	0.553		
R^2	0.0252	0.0249	0.0215
adjusted R^2	0.0197	0.0206	0.0197

timally just on the piece rate. We did not include contract duration to avoid multicolinearity with the last contract period dummy. Also if we replace the dummy with offered contract duration, the influence is insignificant. Unfortunately these results have to be handeled with caution as we have a very low R^2.

Next, we come to contractual changes and their influence on effort. In a long-term contract the only possibility for a worker to react to a change in terms of contract is to adjust effort. Thereupon, only in treatments T and U effort should change as workers should only consider a piece rate change in their effort choice. In all other treatments the piece rate cannot be changed by the employer.

H_0G: There is no correlation between piece rate and effort choice in treatment U and T.

The Pearson Product-Moment correlation between changes of the piece rate and changes in effort in treatments U and T is positive (0.236 and 0.036) but insignificant (P=0.111 and P=0.708 respectively). Workers do not adjust effort to a change in the piece rate to the same degree if we look at the actual changes. If we only look at directional changes (positive or negative adjustments) applying the Spearman-correlation we find positive and significant correlations for both treatments U and T (Sp.-corr.: 0.262 (P=0.008) and 0.665 (P$<$ 0.001)). Hence, workers reply to increases of the piece rate with higher effort and to decreases with lower effort and act to a certain degree according to the theoretical solution. The result is as follows:

Result G *Workers in long-term contracts of treatment U and T react to changes in the piece rate with a change in effort of the same sign. H_0G can be rejected.*

As we already found that workers on average exert higher effort than optimal in all but two treatments and that optimality only depends on the piece rate, we also want to look at changes of the fixed wage as those could be another influencing factor in the workers' effort decisions. To keep comparability, we now look at changes in worker utility resulting from a change in the terms of contract. We want to find out if the worker still exerted the same effort as in the previous period. We differentiate between long-term contracts and renewed contracts. Renewed contracts are defined as a voluntary relationship of more than one contract.

H_0H: There is no causal dependence between a change in workers' utility from one period to the next and changes in effort for long-term as well as for renewed contracts.

We ran linear regressions of utility changes on effort changes to identify causal relationships (Table 4.9). For all treatments except PU and both long-term and renewed contracts, the constant is insignificant. For renewed contracts an

Table 4.9: Regression of Effort on Utility β (Std.Dev.) *P-Value*

long-term	N	PU	U	PT	T
constant	-	0.179	0.023	-0.061	0.056
		(0.062)	(0.085)	(0.058)	(0.069)
		0.775	*0.791*	*0.298*	*0.416*
utility	-	0.222	0.135	0.039	0.388
		(0.146)	(0.155)	(0.070)	(0.082)
		0.130	*0.387*	*0.582*	*<0.001*
R^2	-	0.017	0.012	0.002	0.171
adj. R^2	-	0.010	0.000	0.000	0.163

renewed	N	PU	U	PT	T
constant	-0.087	-0.050	-0.048	0.082	-0.024
	(0.060)	(0.040)	(0.052)	(0.051)	(0.061)
	0.152	*0.209*	*0.359*	*0.108*	*0.689*
utility	0.435	0.455	0.308	0.238	0.374
	(0.085)	(0.055)	(0.068)	(0.056)	(0.070)
	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*
R^2	0.229	0.208	0.126	0.063	0.166
adj. R^2	0.220	0.205	0.120	0.060	0.160

increase in utility significantly increases exerted effort for all treatments, for long-term contracts this effect is only prevalent for treatment T. But as again, the R^2 is very low, we are not able to draw any conlusions from these regressions.

RESULT H *H_0H cannot be rejected.*

In real life we observe few wage cuts in long-term relationships, although employers need to adjust employment to market movements (Bewley (1998) and Agell and Bennmarker (2007)). Their only possibility would be to substitute long-term contracts by recontracting with already known workers. Table 4.10 shows the percentages of short- and long-term contracts offered and accepted. The rate of acceptance of long-term contracts is always lower than that of short-term contracts. The more flexibility an employer has in adjusting wages, the more long-term contracts are offered. This also corresponds to Result A.

Table 4.10: Short- and Long-term Contracts

	N	PU	U	PT	T
short-term offered	76.7	74.3	75.1	62.9	53.7
- thereof accepted	77.2	77.5	80.3	78.9	78.2
long-term offered	23.3	25.7	24.9	37.1	46.3
- thereof accepted	55.0	60.4	66.1	56.8	64.4
renewed of all offered	22.3	28.8	34.3	27.4	18.6
only one partner wants renewal	52.1	41.5	41.8	39.1	50.0
- thereof only employer	45.9	56.2	65.2	69.6	87.3

Participants contract renewal behavior is different over treatments (χ^2-Test) as well as they are offering long-term contracts to a different extent. This is also reflected in Result B.

Employers should offer a new contract to a worker if the match was successful, i.e. if they had positive profits. Workers should also opt for rematching, if their experience with the respective employers was positive.

> H_0I: Agreement to rematching is independent of the participants' payoffs.

We again used the χ^2-test to see whether opting for rematching is independent of the payoff to both types of players. For employers, this decision depends on the period's payoff, for workers there is only a dependency in treatments PU and PT.

> RESULT I *Employers opt for rematching if their payoff from the match was positive, in workers' behavior there is only an interdependence for treatments PU and PT.*

4.2.2 Summary of Experimental Results

On the employers' side, offered contract duration is increasing with the flexibility of contracts. The less strict the rules to wage adjustment are, the more long-term contracts are offered. As market wage is stochastic, employers incur with long-term contracts the risk of not being able to profit from low market wages and thus offer shorter contracts the less flexible a contract can be designed. Employers' contract offers are more generous than expected: Except for treatment T, piece rates are on average around 0.5 and are significantly higher than optimal piece rates.

Workers' contract acceptance does not differ between treatments. But long contract durations and high market wages in the offer period deter them from accepting a contract. Piece rates are the main criterion to accept and the probability to accept an offered contract decreases in later periods. Compared to optimal contract acceptance, workers accept fewer contracts, which is, they decline contracts with a higher expected utility than they had in the same number of periods with the expected market wage. Employers' high piece rate offers are rewarded with higher than optimal effort choices. That means, when an employer offers a high piece rate she is rewarded by even higher effort than would correspond to this piece rate. Accordingly, there is reciprocal behavior by workers.

When it comes to renewed contracts, we observe a higher probability to accept a contract offer. Workers seem to start trusting to an already known employer which makes them accept their contracts more often than those of newly matched employers. Employers opt for rematching if their gain was positive and workers do so for a positive utility except for treatment T. Maybe workers do not want to depend on the same employer when she has full flexibility of wage adjustment. Nevertheless, the afore mentioned higher acceptance rate in rematched pairs does not differ between treatments.

4.3 Conclusion

In theory as well as in our experiments, long-term employment was possible in two ways: Partners could either conclude long-term contracts or mutually agree to rematching. The theoretical model predicted only differences between the completely flexible treatment and the other treatments with some inflexibilities to wage adjustment in an existing contract. In the experiments we observed shorter contracts the more restricted the situation was. This corresponds to the empirical study by Bewley (1998) and the data from EuroStat mentioned in the introduction: Participants seemed to be more sensitive to regulations than theoretically expected. But in the treatments of the experiment they also had the possibility of a long-term relationship by recontracting and thus, circumventing regulations. Nonetheless, offered contract duration, effort levels, and opting for rematching varied significantly over treatments.

We further observed reciprocity on the part of workers: High wage offers were rewarded with even higher efforts. Here the results of Agell and Bennmarker (2007) and Bewley (1998) from manager enquiries are supported: They stated that the main reason for stable wages during a recession is the fear of workers punishing falling wages with lower effort. The theoretical coherence between piece rate and effort is supported by our data, but the response is more intense than expected. In contrast to the managers of Bewley's survey, employers in the experiment decrease wages and are thus punished by lower efforts.

It seems that the complex concept of effort smoothing does not influence employers and workers in their decisions, but they seem to be influenced by behavioral guidelines they take from everyday life. Thus, the theoretical predictions are only a benchmark to predict behavior which is qualitatively met, but quantitatively actual behavior is more extreme.

4.4 Appendix

The following instructions are for treatment PU and translated from German. For other treatments they differed according to the descriptions of section 4.1.2.2.

Instructions

In this experiment you can earn money which will be paid to you at the end of the experiment in cash. The experiment lasts **10 periods**. How much you will earn depends on your and the decisions of other participants. Every participant decides isolated at his computer terminal. Communication with other participants is not allowed.

Participants are randomly assigned to the roles of an employer (AG) or a worker (AN). You get to know your role at the beginning and keep it during the whole experiment.

Every participant has an initial endowment of **150 GE** (currency units).

Run of the Experiment

At the beginning of each period the period's market wage M in GE is announced to all group members. At this wage, every worker is employed if not contracted otherwise with an employer. Only the market wage of the present period is known, all future market wages are unknown. Every employer is matched with one worker and offers a work contract to him. This contract consists of a **fixed wage**, the **contract duration** and the **worker's fraction** of the produced quantity. Every worker can accept or decline his contract. If he accepts the contract, the worker chooses the production quantity. Employers and workers are paid according to the concluded contract. At the end of a contract, employers and workers are asked whether they want to interact again with the same person in the next period. If both agree, they are matched again in the next period.

Run of the First Period

1. The random market wage for the present period is announced. The market wage can assume integers from 13 to 30.

2. Employer-worker pairs are matched randomly.

3. The employer offers a contract. The contract consists of the following:

   - A fixed wage F in GE with $F \geq 0$.
   - A fraction a with $0 \leq a \leq 1$ of the production quantity for the worker.
   - The contract duration L, which is an integer with $1 \leq L \leq$ number of remaining periods.

4. Workers see the contract "their" employer offers, and decide if they want to accept this contract or not. If not accepted, the worker gets the market wage and the employer gets a return of zero.

5. If the contract is accepted, the worker chooses the production quantity Q which is sold for 10 GE. The division of the production quantity is given by a.

   The return to the worker from an accepted contract in this period is:

   $$F + 10 \cdot aQ - 1/2 \cdot Q^2$$

   The employer's return in this case is:

   $$10 \cdot (1 - a)Q - F$$

   If the worker declines the contract, he gets the market wage. The employer is left with a return of zero.

6. Earnings of the period and the sum of all period's returns are shown in GE on the computer screen.

Run of Later Periods

For participants who are not yet in a long-term contract, the run of a period is like the first period. The offered contract duration in this case may not be larger than the number of remaining periods. The employer of a pair in a long-term contract is allowed to increase the fixed wage after the period's market wage is announced. Then all workers choose their production quantity Q.

If a contract ends, employer and worker in this pair are asked whether they want to be matched again with the same partner in the next period. If both agree, the pair can conclude a new contract in the next period. Otherwise, both are randomly assigned to new partners.

In a long-term contract the worker's fraction of the production quantity and the contract duration do not change, while the fixed wage can be increased by the employer in every period. A contract with a changed fixed wage is automatically accepted, but the worker chooses the production quantity every period anew.

"History"

During the experiment you can at any time call your "history" by pressing the button at the lower bound of your computer screen or the key F1. The following information for previous periods is given in the history: period, market wage, fixed wage, fraction AN, duration, acceptance, quantity, return AG, and return AN. Duration is here the number of contract periods left.

Payment

You are paid at the end of the experiment. The return of all periods are added and converted into Euros with a conversion rate of 0.05 Euro per GE. Payment is anonymously.

Questionnaire

Before the experiment starts, you will be asked some questions on the computer screen about the rules of the experiment. If you do not understand any of the questions, please ask the experimenter.

Summary of Notation

a	worker's fraction of production quantity, $0 \leq a \leq 1$
F	fixed wage, $0 \leq F \leq 60$
L	contract duration, $1 \leq L \leq$ number of remaining periods
M	market wage, $M \in 13, 14, ..., 30$
Q	production quantity, $0 \leq Q \leq ...$
GE	currency units
AN	worker
AG	employer

Chapter 5

Summary and Conclusion

This thesis discussed different aspects of a work relationship: On one hand, we looked at selection problems when workers differ in their intrinsic work motivation as well as in their qualification, on the other, we investigated the effects of contractual flexibility on contract duration.

At first, in Chapter 2, a motivating real-effort experiment showed, that a worker's qualification does not fully describe all of his characteristics, that are relevant to a work relationship and that there may be other, unobservable characteristics besides qualification. At the beginning of the experiment worker-participants chose their level of qualification (their productivity) by themselves. After concluding a (complete) contract with an employer-participant, they exerted effort although remuneration was lump sum and independent of their behavior. Thus, we found participants to act intrinsically motivated in a labor market setting with another participant instead of the experimenter being the contract partner.

In the theoretical model of Chapter 3, agents' work motivation was introduced into a standard utility function. Intrinsic work motivation is assumed to be innate, hence agents cannot choose the degree of intrinsic motivation. What they are able to choose, is their level of qualification. They do this by deciding in favour of or against taking part in costly qualification measures. As their resulting skill-level is observable to principals, they screen with respect to motivation knowing the endogenously chosen skill type of the worker. With continuously distributed motivation, investing into qualification is preferred either by all or none of the motivational types. The investment decision is independent of motivation as we assume principals not to update their beliefs regarding the distribution of motivated agents on a certain skill-level. A principal optimizes her contract offer, assuming the initial distribution of motivation for both skill-levels.

With discrete motivational levels (motivated and unmotivated) and principals knowing the actual distribution of motivational types on both skill-levels, there is shut-down of unmotivated agents when their fraction at the respective skill-level becomes to low, as the low chance of meeting them does not justify offering an information rent for the motivated agents. For higher fractions of unmotivated agents, employers are willing to incur these cost, as the probability to be left without an accepted contract outweighs these. This result is quite rare in screening-models. Still there is an incentive for motivated agents to invest into high qualification as this increases their information rent whenever the fraction of unmotivated agents in both skill groups is equal. Unmotivated agents are, irrespective of their skill-level, the "bad types" in this screening game and thus receive always just their outside option. But as investment costs are a fraction of future wages, becoming high-skilled is also affordable to unmotivated agents and they are indifferent regarding qualification. Thus, motivated agents' return from investing decreases with an increasing rate of qualification in the population.

We showed that an educational system with qualification cost depending on the wage, as the German BaFöG, leads to higher overall qualification and hence, to increased efficiency. This result is independent of the assumption of a motivational term in the utility function and occurs whenever workers differ in two independent dimensions, where one is naturally given and unobservable (like the ability to work in a team) and the other is at the worker's choice and observable to a prospective employer (like taking part in productivity enhancing measures).

In Chapter 4, a different situation with homogenous workers but incomplete contracts is introduced. Instead of contracting on wage and quantity, employers offer a combination of lump sum wage and piece rate for a certain number of periods. Workers who accepted a contract, afterwards choose effort in every period of the existing contract. At the end of the last contract period both partners were able to opt for rematching, which was accomplished, if both wanted to. The worker's outside option was a stochastically determined market wage. In theory, as well as in the experiment, we looked at different degrees of contractual wage flexibility: With downward fixed piece rates it is optimal for both partners to conclude long-term contracts, as the worker is insured against low market wages and the employer profits from effort-smoothing. With flexible piece rates, this insurance character vanishes and employers cannot count on positive efforts by workers. Thus, in this treatment of our experiment at most two-period contracts should be offered. Referring to the empirical results of Bewley (1999), in the experiment we expected long-term contracts in situations with downward adjustable wages to be replaced by series of short-term contracts. What we observe, is that only the relation of short- to long-term contracts offered decreases with increasing flexibility: There are no significant differences over treatments in opting for rematching. Wages higher than optimal are rewarded with high efforts. The reciprocal interdependencies seem to rule the work-relationship.

Coming back to the title question, "What is good work?", we were able to identify working conditions that at least do not have a negative effect on intrinsic work motivation, by analyzing the psychological literature. In the motivation experiment we also found that an interesting and diversified task can lead to high effort although payment is independent of performance.

Employers would characterize a good job by high effort, combined with low wage claims. In the screening models, workers could be separated regarding those characteristics but we saw in the motivation screening with only two levels of motivation (unmotivated and motivated) that selection is not always most profitable to the employer. The selection mechanisms improved the situation of both contractual parties when information asymmetries could not be overcome otherwise.

In the experiments of Chapter 4 we saw, that an employer-worker-relationship is determined and influenced by more than just contractual facts and selfish rationality. The partner with the first move was rewarded for trusting in the second mover. Trust was given in the form of offering a positive lump sum wage under non-contractible effort, it was reciprocated by higher effort than justified by the piece rate. In most cases, this deviation from optimal behavior improved the profits of both partners as it increased the set of enforceable outcomes, compared to both acting purely selfish. These results are in line with Fehr, Gächter, and Kirchsteiger (1997) who experimentally tested work relationships with incomplete contracts on reciprocal behavior by the employee and found a large potential for efficiency gains, when contracts allow for trust and reciprocity. We found that also under incomplete contracting, employees seldomly exploit the situation that their effort is not contractible.

If we want to define “good work” for both, employers and workers, we can state that a contract that suits the employee’s characteristics and takes into account the informational situation, is able to overcome the conflicting interests to guarantee a high degree of satisfaction for both sides: “Good work” is the result of a good contract.

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