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Flexible work arrangements and precautionary behavior: Theory and experimental evidence[☆]

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ABSTRACT

In the past years, work-time in many industries has become more flexible, opening up a new channel for intertemporal substitution: workers might, instead of saving, adjust their work-time to smooth consumption. To study this channel, we set up a two-period consumption/saving model with wage uncertainty. This extends the standard saving model by also allowing a worker to allocate a fixed time budget between two work-shifts. To test the comparative statics implied by these two different channels, we conduct a laboratory experiment. A novel feature of our experiments is that we tie income to a real-effort style task. In four treatments, we turn on and off the two channels for consumption smoothing: saving and time allocation. Our main finding is that savings are strictly positive for at least 85 percent of subjects. We find that a majority of subjects also uses time allocation to smooth consumption and use saving and time shifting as substitutes, though not perfect substitutes. Part of the observed heterogeneity of precautionary behavior can be explained by risk preferences and motivations different from expected utility maximization.

1. Introduction

Flexible work arrangements are increasingly common. The so-called gig economy, for instance, currently changes the environment for both labor supply and consumption/saving decisions of many professionals like ride-sharing drivers, bicycle couriers, craftspersons, and many other professions. These professionals increasingly supply labor on online platforms like Lyft, Uber, Delivery, HomeAdvisor or Upwork without submitting to a specific work-time schedule. In contrast to traditional work arrangements with fixed hours of work, to freelance allows workers to determine their average shift-wage and its risk

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endogenously even if the wage rate varies exogenously over time. By allocating a fixed amount of work-time, a freelancer can adjust the average wage and smooth his or her marginal utility over time. Through this allocation of time between work-shifts (we will refer to this allocation decision as *shifting*), the same intertemporal substitution may be achieved as by saving (i.e., transferring resources from one period to another). Allocating time instead of saving monetary value is institutionalized in many countries. A prominent example is *working time banking*, where workers keep track of hours in order to build up credits or deficits in hours worked, with specific rules for extreme or long-term deviations from contract hours. Working time banking is the main form of flexible work arrangements in Germany and is also very common in Scandinavian countries, where more than 50 percent of employees have the possibility to work under flexible hours (Plantenga and Remery 2010). In the US, an example for shifting possibilities is the standard employment arrangement of New York City cabdrivers, where the driver leases the cab for a fixed period, usually a 12-hour shift, a week, or a month and is free to work as few or as many hours as she wishes within any given 12-hour shift. Rich data on daily cabdrivers' labor supply has been viewed through the lenses of a static target earnings model (Camerer et al. 1997), the standard intertemporal model (Farber 2005), and other reference-dependent models (Farber 2008), which led to a fruitful debate on highlighting expectations about future earnings possibilities as a determinant of the optimal duration of a shift (Farber 2015). As wages in the gig economy are often much more volatile than for workers with fixed hours, anticipated wage uncertainty may strongly increase the gig workers' desire to transfer value over time for precautionary reasons.[3] However, the extant empirical literature is ambiguous on how important precautionary behavior is or—more importantly—whether it even exists in the first place (e.g., Fulford 2015). If saving and shifting are substitutes, flexible work arrangements may reduce savings and explain at least partly the lack of evidence.

In this study, we provide theoretical and experimental evidence on behavior underlying many questions raised by the recent changes in work arrangements. First, we set up a model to show that labor supply and savings are perfect substitutes in theory and discuss the consequences for consumption and labor supply decisions. Second, we test the comparative statics of this model using laboratory experiments. Here, we are able to control wage risk, which is not possible using survey or administrative data.[4] Third, we examine if subjects' precautionary choices are in line with their homegrown risk preferences. We also classify subjects according to three different behavioral strategies implying different optimal choices: standard optimization, risk pessimism, and hand-to-mouth behavior.

We set up a two-period model in which the wage is certain during the first period. In the second period, a mean-zero shock that takes one of two possible states of the world perturbs the wage (while the expected wage remains identical to that of the first period). We induce preferences that resemble a progressive tax system and compare decisions in four scenarios: (i) a hand-to-mouth scenario where neither a saving nor a shifting decision can be taken; (ii) a scenario where saving is allowed; (iii) one where shifting is allowed; and (iv) another where *both* saving and shifting are allowed. We formulate four hypotheses to test whether the hand-to-mouth model, the standard precautionary saving model, and the precautionary shifting model work as predicted. We also test if and how subjects substitute saving and shifting. While these four hypotheses test the comparative statics of our model, we use the classification exercise (mentioned in the previous paragraph) to examine deviations from optimal choices.

We translate our model directly into a lab experiment to test our hypotheses. The subjects work for a fixed amount of time in a real-effort style task (the ball-catching task by Gächter et al., 2016) in order to generate income. Earned income then enters a concave payoff function, separately in each work-shift. To produce output, monetarily costly effort has to be exercised; the cost per unit of effort increases disproportionately. During the first period of a treatment (the first half of work-time), a certain amount is paid for each unit produced; during the second period (the remaining half of time), this amount is uncertain and can take either a high or a low realization. All decisions are taken under uncertainty about the realization of wage in period 2. In a within-subject design, we test the comparative statics predictions of our model in four different treatments. Either, we allow no saving and no shifting, or only one of the two, or both. Our implementation of savings is relatively straightforward: unconsumed shift 1 income together with second shift's income is automatically spent for consumption (i.e., the sum of both enters the concave payoff function of shift 2). When shifting is allowed, subjects can end their first work-shift whenever they like (which means that shifts do not need to coincide with periods). As with savings, income in the time not spent in shift 1 under wage of period 1 is transferred to the concave payoff function of shift 2. This allows to earn extra income in shift 2 equivalent to saving by choosing to finish shift 1 early. The presence of shifting as an alternative for saving provides a rationale for why people stop work even if wage increases are observed ex-post and why observed precautionary savings may be smaller than predicted, even if shifting and saving are imperfect substitutes.

We answer three key questions. First, do subjects use the saving channel? The results reject the non-existence of precautionary saving with at least 85 percent of the subjects saving. Second, do subjects use the shifting channel? At least 52 percent of all subjects engaged in precautionary shifting. Third, are saving and shifting perfect substitutes? We find that saving and shifting are substitutes but do not find support that they are *perfect* substitutes on aggregate. One way to test

[3] This has been documented for gig economy pay packets in the UK, which are particularly volatile for low-paid workers (Tomlinson 2018). But variation in wages may also be present in non-gig economy jobs due to bonuses or revenue-dependent compensations.

[4] Our study provides evidence that complements research with data from outside the lab. Many attempts to quantify causal effects in real-world data are plagued by problems like division bias in hourly wages (see, e.g., Borjas 1980), absence of credible measures of wage risk, effort, wealth or shift-specific information, the presence of many different saving motives or provided incentives. In lab experiments, we have more control over these variables than with observational data.

this relies on the hypothesis that if they were perfect substitutes, expected payoffs would not significantly differ across treatments where either saving or shifting are possible. However, expected euro earnings differ at all conventional levels of significance. In addition, we also examine whether subjects provide more effort when the wage is certain than when the wage is risky. We find that subjects follow this prediction and reduce effort in our setting by about 18 percent when shifting is not allowed. Although we can classify behavior of more than 61 percent of subjects to be consistent with our model, we find substantial heterogeneity in saving behavior. In particular, our results suggest that hand-to-mouth behavior and risk pessimism need to be taken into account in addition to expected utility behavior.

The paper is structured in the following way: After providing an overview of the literature in the next section, Section 3 presents our extension of the standard model of consumption and labor supply and our hypotheses, Section 4 describes our experimental design and procedures, and Section 5 presents and discusses our findings. Finally, Section 6 summarizes and concludes.

2. Review of the literature

Precautionary saving is defined as the difference between consumption under certainty and in the presence of risk (see Kimball 1990, p. 55). On the one hand, there is empirical evidence for considerable savings of up to 70 percent of total wealth for precautionary reasons (Gourinchas and Parker 2002; Carroll and Samwick 1998; Kazarosian 1997). On the other hand, some studies find only small precautionary wealth (Engen and Gruber 2001; Lusardi 1998; 1997; Guiso et al. 1992). Fulford (2015) reports evidence that survey participants savings do not respond to income uncertainty. Hurst et al. (2010) and Fossen and Rostam-Afschar (2013) argue that estimates are sensitive to whether they include business owners. As these often have more flexible work arrangements (Jessen et al., 2017 show that employees can adjust hours only after about two to four years but business owners immediately), this raises the question if this flexibility is used to substitute savings by shifting.

Quasi-experimental settings go some way in this direction. Fuchs-Schündeln and Schündeln (2005) show that saving rates of most East Germans but civil servants (who enjoy a high income certainty) increased sharply after the natural experiment of the German unification. In contrast, West Germans—who would have been subject to more selection into jobs based on risk preferences—exhibited a negligible difference in saving rates between civil servants and others with riskier jobs, either before or after reunification.

Duffy (2016, section 2.1) surveys the literature on consumption/saving decisions using laboratory experiments. Here, we review the most important papers from this strand of literature to highlight how our experiment differs from them. Ballinger et al. (2003) study social learning (over a life-cycle of 60 periods subjects had to take saving decisions after receiving a randomly determined income). Social learning in an intergenerational structure was mimicked by allowing the subjects in the role of the younger-generation individual to sit next to an older-generation subject and to observe its behavior and to interact with him or her during some periods before taking his or her own decisions (and being later on joined by yet another younger-generation individual). Ballinger et al. find that subjects who could learn from ‘elders’ do better than the ones who could not. Also, the subjects behavior is qualitatively correct, but they save too little early in the life-cycle. Brown et al. (2009) test two explanations for this observed undersaving. The first reason, bounded rationality, was tested by allowing some subjects to observe other (well-performing) subjects behavior. Subjects who could learn socially performed better than the subjects who only learned individually. The second reason, a preference for immediacy, was examined in a second experiment. Two groups of thirsty subjects received soft drink sips as period consumption. One group of subjects received their consumption immediately, the other group only with a delay. Here, the former group undersaved compared to the latter group and showed a lower total consumption level. Ballinger et al. (2011) correlate measured personality traits and cognitive abilities with the performance in a savings experiment and find that two cognitive ability scales predict savings performance best.

What are the major differences between these previous experiments and ours? We test how subjects respond to different institutions, i.e., the existence of different savings channels. Another difference is that, in all mentioned experiments, income was randomly assigned; in our experiment, subjects have to work on a real-effort style task to generate income. This novelty is crucial as shifting as alternative to saving only is possible, if there is a period of time in which income can be earned that can be split into shifts. Whereas the papers reviewed in Duffy's survey consider complete life-cycles with up to 60 periods, our experimental design only considers two periods—the shortest time-span in which saving is meaningful. We consider this simplicity as advantage for theory-testing because it is easy to communicate to subjects and easy to test. This design should not be interpreted as a complete life-cycle but as an episode in an individual's life.

Our study also relates to experimental research on labor markets (see Duffy 2016, section 4.2). Dickinson (1999) sets up a model where workers can substitute on- and off-the-job leisure and tests it in experiments. In one of the conducted treatments, the subjects are only allowed to choose their effort (with fixed work hours), and in another, they are also allowed to leave the experiment early. In both treatments, the piece-rate for the real-effort task is varied within-subject. The results confirm the predictions of the model: subjects in the experiments substituted leisure on- and off-the-job, which explains the negative substitution effects on wages on hours worked. We give an alternative explanation for negative wage elasticities, since a wage increase may change the optimal allocation of work-shifts. In contrast to Dickinson, we only run treatments where total work-time is fixed. We are not interested in decisions under leisure vs. work-time tradeoffs, and,

Table 1
Treatments and Choices.

Treatment	Static	Intertemporal		Choices		
	Effort	Saving	Shifting			
Base	Allowed	Not Allowed	Not Allowed	e_1, e_2		
Save	Allowed	Allowed	Not Allowed	e_1, e_2	s	
Shift	Allowed	Not Allowed	Allowed	e_1, e_2		t
Save & Shift	Allowed	Allowed	Allowed	e_1, e_2	s	t

Source: Authors' calculations.

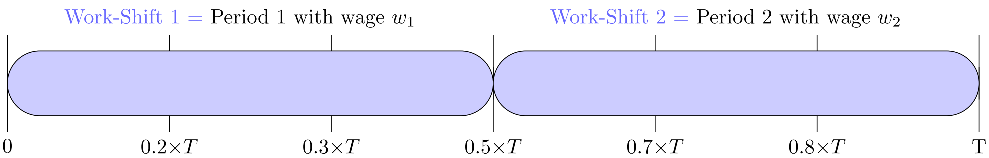


Fig. 1. Labor Supply and Wage Changes in the Standard Model *Source:* Authors' calculations'.

also, as we do not want to let subjects opportunities to earn money or otherwise spend their time outside of the lab affect their decision on how long in total they would like to work on our real-effort task.

3. Theory

3.1. Treatments & intuition

Here, we give an intuition of the four scenarios that arise due to the two channels (saving or shifting) that workers can or cannot use for precautionary payoff smoothing. In Section 3.2, we introduce the specific functions and parameters used in our model, in Section 3.3, we show the optimization problems and optimality conditions, and in Section 3.4, we show the models' point predictions and corresponding hypotheses for our experiments. Our objective is to test if and how subjects use the different precautionary channels.

As indicated in Table 1, subjects may choose for each of two shifts effort $e_1 \geq 0$ and $e_2 \geq 0$ in all treatments, the amount of savings to be transferred to the second shift $s \geq 0$ in treatments Save and Save & Shift, and/or when to stop shift 1 by choosing normalized length $0 < t \leq 1$ of shift 1 in treatments Shift and Save & Shift. Effort produces output which is remunerated with a certain piece rate w_1 in the first period and a risky piece rate w_2 in the second period. The realization of the wage shock is only revealed *after* all decisions have been made.

Treatment Base Many consumers lead a 'hand-to-mouth existence: they simply consume their net income and do not save (Kaplan and Violante 2014). This may be due to unsophisticated behavior (non-optimizing, or 'rule-of-thumb consumers), or due to the inability to trade in asset markets due to infinitely high transactions costs. In our experiment, we restrict subjects in Base to be hand-to-mouth consumers, i.e., $t = 0.5$ and $s = 0$. Subjects can only exercise effort e_i in both work-shifts $i = 1, 2$ to produce output. Base serves as a control treatment where intertemporal consumption smoothing is not possible.

Treatment Save: While hand-to-mouth behavior can be observed in many situations, another important behavioral tendency is to 'save for a rainy day. Precautionary saving has received much attention in the literature, although, as mentioned in Section 2, evidence for it is mixed. The main purpose of Save is to examine whether the savings channel is used by the subjects. In each work-shift, effort e_i is chosen, and, at the end of the first work-shift, the savings amount $s \geq 0$. The saving amount s is then added to the income earned in the real-effort task in shift 2.[5]

Treatment Shift: Another option for shifting income intertemporally has been missed to date: precautionary shifting. Based on the setup in Base, in Shift we introduce the possibility to choose when work-shift 1 ends.[6]

Figs. 1 and 2 illustrate this. In the standard model (as in Base and Save) in Fig. 1, labor supply is only chosen according to the wage of the period under consideration. This setup rules out the possibility of influencing the expected wage by choosing the length of a work-shift.

Fig. 2 shows an example where a worker ends the first work-shift early (as possible in Shift and Save & Shift). Hence, he or she earns wage rate w_1 in this first work-shift. In the second work-shift, he or she earns both wage rates: w_1 for each unit produced in the time until $0.5 \times T$ and w_2 for each unit produced from $0.5 \times T$ until T (where T is total absolute time). In this way, we generalize the standard model, which does not take into account that the choice of labor supply may determine the (expected) average wage and that income enters the consumption function at the end of a shift—not at the end of a period.

[5] Note that the individual is borrowing-constrained. We introduced this constraint to ensure that the subjects in our experiments do not take on so much credit that they would not be able to pay it back later.

[6] Cf. the reduced form estimates for optimal stopping behavior discussed in, e.g., Farber (2015, 2008).

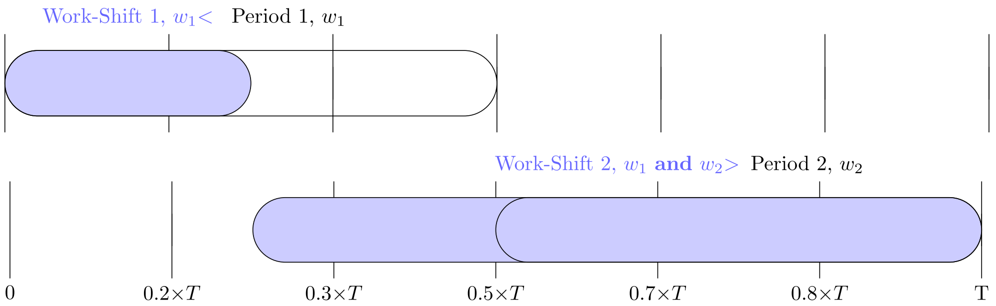


Fig. 2. Labor Supply and Wage Changes in the General Model *Source:* Authors' calculations'.

Since intertemporal substitution can be achieved as in Save, in Shift optimizing subjects find it optimal to finish work-shift 1 early given the risk in period 2 (and to smooth shift-specific effort). These decision-makers will use the certain period 1-wage in work-shift 2 to build up a level of precautionary wealth before working under the risky wage. Assume that someone has two jobs, one with a certain wage, another one with an uncertain wage, and the flexibility to arrange when to work on which job. It would be optimal to mix some of the certain wage to the uncertain (in anticipation that the bad state of the world might realize).

Treatment Save *&* Shift: Here, workers have the option of both determining when to finish a work-shift *and* whether to transfer value between shifts. Hence, we combine the features of Save and Shift. In the general setup of this analysis, shiftings and savings are perfect substitutes. The comparison of the data from Save and Shift shows whether subjects achieve the same expected payoff by choosing either s or t. Together with the observations from Save and Shift, the observations from Save & Shift allow us to analyze which combination of work-time allocation and saving is chosen by the subjects (as theory does not make a statement whether one of the extreme cases of only saving or only shifting is chosen or a combination of the two).

3.2. Parametrization

Consumption function: In each work-shift, after-tax consumption is related to income by a scaled and shifted isoelastic function

$$c_i(y_i) = \lim_{\tau\to 1} \zeta\left([1/(1-\tau)(y_i^{1-\tau}-1)] - \eta\right) = \zeta\left(\log(y_i) - \eta\right). \tag{1}$$

In the experiment, we use this as payoff function and frame it as a consumption function instead of referring to utility. This constant relative risk aversion (CRRA) consumption/utility function has a positive third derivative implying prudence and thus risk will affect optimal choices (Kimball 1990).[7] Given this precautionary motive, there are two margins of choice that reflect precautionary behavior, both of which we will analyze. First, as in the standard model, prudent individuals have an incentive to save in anticipation of wage risk. Theoretically, insurance against wage risk is the only reason for saving in our experiment since the expected wage is identical in periods 1 and 2. The possibility to end a work-shift before or after a change in wage risk creates another route to engage in precautionary behavior: prudent individuals have an incentive to sacrifice some payoff in shift 1 and end it before the wage becomes uncertain to ensure that some income from the certain wage rate enters the consumption function in the second shift.

Cost function: We specify the following cost function for effort:

$$\nu_i(e_i) = \varphi \sum_{k=0}^{e_i} k^2 = \frac{\varphi e_i(e_i+1)(2e_i+1)}{6}. \tag{2}$$

At the beginning of each work-shift, the cost function is reset to zero. This and the convex form of the cost function resembles fatigue effects with increasing effort. We defined this cost function with our experiments in mind, where effort levels are discrete.[8]

Production function: We do not impose a production function in the experimental design as we suspect productivity to be highly heterogeneous. To analyze our data, we only need to assume two properties for our assumed underlying production function: (i) for a unique solution, we require a positive intercept or a concave production function (and concavity of the

[7] Note that without a positive third derivative of the utility function, there would not be a precautionary motive. Individuals with, e.g., a quadratic utility function at $\tau = -1$ (where the third derivative is zero) have no saving motive in standard models when facing an uncertain future income (with the same expected income as present income). In contrast, the function shown in Eq. (1) induces a precautionary motive to save because of the uncertainty. See Jappelli and Pistaferri (2017, Sections 4 and 6) for further explanations.

[8] Instead of this convex cost function, alternative specifications with linear cost functions would give unique levels of effort as well. We chose this specification to make increasing marginal costs more salient.

production function for our task was already shown by Gächter et al. 2016); (ii) stability of the production function over time, i.e., no or only small learning effects, as subjects should not be able to generate different incomes at different times of the experiment. Following Gächter et al. (2016) we use a fractional polynomial function to estimate the expected production in a given shift as a function of effort e_i and normalized time t in shift 1 as

$$q_1(e_1,t) = t\big(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\big), \tag{3}$$

$$q_2(e_2,t) = (1-t)\big(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\big). \tag{4}$$

This specification generalizes Gächter et al.'s approach and multiplies every term with the time spent working in a shift.

3.3. Optimization problems and optimality conditions

Consider an individual working in two shifts, where expected total consumption $E_\varepsilon C$ is the sum of expected consumption in work-shift 1, $E_\varepsilon[c_1]$, and work-shift 2, $E_\varepsilon[c_2]$. In both work-shifts $i = 1, 2$, shift-separable consumption is a concave function of income $c_i(y_i)$. We abstract from discounting. The individual's problem is

$$\max_{e_1,e_2,t,s} E_\varepsilon C = E_\varepsilon[c_1(y_1)] + E_\varepsilon[c_2(y_2)]. \tag{5}$$

A period refers to the time in which either the certain or uncertain wage is paid while a work-shift refers to the time in which the individual continuously exercises effort. Thus, work-shift specific income depends on exogenously given, period-specific wage rates w_j with periods $j = 1, 2$ and three kinds of shift-i-specific choices: effort e_i, savings s, and the choice about the relative length of the first work-shift $t \in (0, 1]$. Both periods joint absolute length is exogenously fixed and lasts T units of time. For simplicity, we assume that each of the two periods takes $0.5 \times T$ units of time. At the beginning of the second period, the period-specific wage rate w_1 changes exogenously to w_2. The first-period wage rate is certain, $w_1 = w$, while the second-period wage rate w_2 is uncertain. In the second period, a mean-zero wage shock ε shifts $w_2 = w + \varepsilon$ either up or down (with equal probability).

The choice of t causes income y_i in each shift to be determined by either the wage of a single period or the wages of both periods. In particular, (expected) income in shift 1 is

$$E_\varepsilon[y_1] = \begin{cases} w_1 \cdot q_1(e_1,t) - \nu_1(e_1) - s & \text{if } t \le 0.5 \\ E_\varepsilon\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_1(e_1,t) - \nu_1(e_1) - s\right] & \text{if } t > 0.5 \end{cases} \tag{6}$$

and expected income in shift 2 is

$$E_\varepsilon[y_2] = \begin{cases} E_\varepsilon\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right] & \text{if } t < 0.5 \\ E_\varepsilon[w_2 \cdot q_2(e_2,t) - \nu_2(e_2) + s] & \text{if } t \ge 0.5. \end{cases} \tag{7}$$

Effort e_i translates into a production quantity according to the production function $q_i(e_i,t)$ from which costs of effort $\nu_i(e_i)$ are deducted. By different choices of t, the individual can determine average shift wages in the generalized model (where we assume that the average shift wages, the weighted period wages in Eqs. (6) and (7), are linear combinations of the two period wages, depending on t); $t = 0.5$ nests the standard model as a special case. Income at the end of a work-shift, before saving, is then the product of relevant wage(s) times relevant production minus effort costs. From this income, savings are deducted in the first work-shift and added in the second work-shift. We specify that income y_i enters the payoff function $c_i(y_i)$ *net* of costs instead of the additive separable valuation of benefits and costs of work (through disutility of labor).[9]

The realization of the wage shock is only revealed *after* all decisions have been made. This makes it possible to isolate the effects of uncertainty (see examples of this approach in theoretical work in Flodén 2006, Parker et al. 2005, Hartwick 2000, and Eaton and Rosen 1980), and is an element of some real-world settings. For example, to get a bonus payment, it might be necessary to allocate effort before the amount of the bonus is known (e.g., because it depends on the business cycle or the success of a group of comparable workers).

Before we numerically solve the model for the parametrization used in our experiments, we describe the optimization problems and the first order conditions (FOCs) in our treatments. By introducing an additional decision variable, t, to the standard model's decision variable s, we model how the individual should behave when facing the otherwise identical situation.

Treatment Base: In the static model, the individual's optimization problem is given by:

$$\max_{e_1\ge 0, e_2\ge 0} E_\varepsilon C^{\text{Base}} = c_1[w_1 \cdot q_1(e_1, t=0.5) - \nu_1(e_1)] + E_\varepsilon c_2[w_2 \cdot q_2(e_2, t=0.5) - \nu_2(e_2)]. \tag{8}$$

[9] Instead of describing the situation of employees, where disutility of work accrues privately, in our model the costs of work are deducted as business expenses before valuation. This resembles the situation of freelancers more closely. The main reason for this design feature is that it disincentivizes precautionary effort, i.e., higher effort in the first work-shift in Save compared with Base. A positive side effect is that it also requires fewer non-linear functions, which makes the experimental setup simpler to explain.

Effort e_i translates into quantity according to a production function $q_i(e_i, t = 0.5)$ from which costs of effort $\nu_i(e_i)$ are deducted. Income at the end of a work-shift is the product of wage times production minus effort costs. With fixed work arrangements, the only choice variable in this setting is effort e_i in each work-shift.

The FOCs for this problem (without using the specifications of the consumption, production, and cost function as described in the previous section) allow us to give some economic intuition. They are given by:

$$\frac{\partial E_\varepsilon C^{\text{BASE}}}{\partial e_1} = c_1'[w_1 \cdot q_1(e_1, t = 0.5) - \nu_1(e_1)]\left(w_1 \frac{\partial q_1(e_1, t = 0.5)}{\partial e_1} - \nu_1'(e_1) \right) = 0, \tag{9}$$

$$\frac{\partial E_\varepsilon C^{\text{BASE}}}{\partial e_2} = E_\varepsilon \left[c_2'[w_2 \cdot q_2(e_2, t = 0.5) - \nu_2(e_2)]\left(w_2 \frac{\partial q_2(e_2, t = 0.5)}{\partial e_2} - \nu_2'(e_2) \right) \right] = 0. \tag{10}$$

These FOCs become zero if the second term (in parentheses in each equation) becomes zero—(expected) marginal revenue equals marginal cost. As the (expected) revenue function is concave (due to the concave production function), and as the cost function is convex, the shown first order conditions have a unique solution. The FOCs *with* the specifications of the consumption, production, and cost function are:

$$\frac{\partial E_\varepsilon C^{\text{BASE}}}{\partial e_1} = \frac{\zeta \left(\frac{\phi e_1(2e_1+1)}{6} - w_1 \left(\beta e_1 + \frac{\alpha}{4\sqrt{e_1}} \right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3} \right)}{\eta - \frac{w_1}{2}\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma \right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} = 0, \tag{11}$$

$$\frac{\partial E_\varepsilon C^{\text{BASE}}}{\partial e_2} = E_\varepsilon \left[\frac{\zeta \left(\frac{\phi e_2(2e_2+1)}{6} - w_2 \left(\beta e_2 + \frac{\alpha}{4\sqrt{e_2}} \right) + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3} \right)}{\eta - \frac{w_2}{2}\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma \right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}} \right] = 0. \tag{12}$$

For these effort FOCs (and the effort FOCs of the following problems), we *cannot* derive an analytical solution.[10] We will solve them numerically in the next section for the parametrization used in our experiments. To save space, we will show the FOCs involving the specific functions of the other three treatments in Section A.1 in the Appendix.

Treatment SAVE: The maximization problem changes in comparison to BASE's: The two work-shifts are now connected via savings:

$$\max_{e_1 \geq 0, e_2 \geq 0, s \geq 0} E_\varepsilon C^{\text{SAVE}} = c_1[w_1 \cdot q_1(e_1, t = 0.5) - \nu_1(e_1) - s] + E_\varepsilon c_2[w_2 \cdot q_2(e_2, t = 0.5) - \nu_2(e_2) + s]. \tag{13}$$

Now, we have to consider three FOCs for the general problem:

$$\frac{\partial E_\varepsilon C^{\text{SAVE}}}{\partial e_1} = c_1'[w_1 \cdot q_1(e_1, t = 0.5) - \nu_1(e_1) - s]\left(w_1 \frac{\partial q_1(e_1, t = 0.5)}{\partial e_1} - \nu_1'(e_1) \right) = 0, \tag{14}$$

$$\frac{\partial E_\varepsilon C^{\text{SAVE}}}{\partial e_2} = E_\varepsilon \left[c_2'[w_2 \cdot q_2(e_2, t = 0.5) - \nu_2(e_2) + s]\left(w_2 \frac{\partial q_2(e_2, t = 0.5)}{\partial e_2} - \nu_2'(e_2) \right) \right] = 0, \tag{15}$$

$$\frac{\partial E_\varepsilon C^{\text{SAVE}}}{\partial s} = -c_1'[w_1 \cdot q_1(e_1, t = 0.5) - \nu_1(e_1) - s] + E_\varepsilon c_2'[w_2 \cdot q_2(e_2, t = 0.5) - \nu_2(e_2) + s] = 0. \tag{16}$$

Again, as in BASE, the first two FOCs state that (expected) revenue equals marginal cost. The third FOC is the consumption Euler equation (which states that marginal consumption in shift 1 should equal (expected) marginal consumption in shift 2). This third FOC ensures consumption smoothing via savings.

Treatment SHIFT: Here, the task is to choose the length of work-shifts via t and, in each work-shift, effort e_i. The maximization problem is:

$$\max_{e_1 \geq 0, e_2 \geq 0, 0 < t \leq 1} E_\varepsilon C^{\text{SHIFT}} = \begin{cases} c_1[w_1 \cdot q_1(e_1, t = 0.5) - \nu_1(e_1)] + E_\varepsilon c_2[w_2 \cdot q_2(e_2, t = 0.5) - \nu_2(e_2)] & \text{if } t = 0.5 \\ c_1[w_1 \cdot q_1(e_1, t) - \nu_1(e_1)] + E_\varepsilon c_2\left[\left(\frac{0.5-t}{1-t} w_1 + \frac{0.5}{1-t} w_2 \right) q_2(e_2, t) - \nu_2(e_2) \right] & \text{if } t < 0.5 \\ E_\varepsilon c_1\left[\left(\frac{0.5}{t} w_1 + \frac{t-0.5}{t} w_2 \right) q_1(e_1, t) - \nu_1(e_1) \right] + E_\varepsilon c_2[w_2 \cdot q_2(e_2, t) - \nu_2(e_2)] & \text{if } t > 0.5. \end{cases} \tag{17}$$

We supply the FOCs for the relevant case $t < 0.5$ (which corresponds to shifting income from shift 1 to shift 2) for the general problem:

$$\frac{\partial E_\varepsilon C^{\text{SHIFT}}}{\partial e_1} = c_1'[w_1 \cdot q_1(e_1, t) - \nu_1(e_1)]\left(w_1 \frac{\partial q_1(e_1, t)}{\partial e_1} - \nu_1'(e_1) \right) = 0, \tag{18}$$

[10] When we plug in all specified and estimated parameters, we end up with polynomials that do not have analytical solutions. Take, for example, Eq. (11) which becomes $0.5 - \frac{10817.3}{\sqrt{e_1}} + 9e_1 + 3e_1^2 = 0$. The numerical solution is $e_1 = 25.3104$.

$$\frac{\partial E_\varepsilon C^{\text{SHIFT}}}{\partial e_2} = E_\varepsilon\left[c_2'\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2)\right]\left(\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)\frac{\partial q_2(e_2,t)}{\partial e_2} - \nu_2'(e_2)\right)\right] = 0, \tag{19}$$

$$\frac{\partial E_\varepsilon C^{\text{SHIFT}}}{\partial t} = c_1'[w_1\cdot q_1(e_1,t) - \nu_1(e_1)]\frac{\partial q_1(e_1,t)}{\partial t} + E_\varepsilon\left[c_2'\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2)\right]\cdot\right.$$
$$\left.\times\left(\left(\frac{-0.5}{(1-t)^2}w_1 + \frac{0.5}{(1-t)^2}w_2\right)q_2(e_2,t) + \left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)\frac{\partial q_2(e_2,t)}{\partial t}\right)\right] = 0. \tag{20}$$

The economic intuition of the first two FOCs does not change compared to the previous treatments. The third FOC ensures the smoothing of (expected) marginal consumption in the two shifts via shifting. Changing the length of shifts allows the individual to determine in which shift the produced output is valuated. Because of the convex specification of the cost function, and the production functions (where the time in a shift enters linearly), all three decision variables have to be adjusted simultaneously.[11]

Treatment SAVE & SHIFT: Now, both saving and shifting are allowed. The individual's maximization problem is given by:

$$\max_{e_1\geq 0, e_2\geq 0, s\geq 0, 0<t\leq 1} E_\varepsilon C^{\text{SAVE\&SHIFT}}$$
$$= \begin{cases} c_1[w_1\cdot q_1(e_1,t=0.5) - \nu_1(e_1) - s] + E_\varepsilon c_2[w_2\cdot q_2(e_2,t=0.5) - \nu_2(e_2) + s] & \text{if } t = 0.5 \\ c_1[w_1\cdot q_1(e_1,t) - \nu_1(e_1) - s] + E_\varepsilon c_2\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right] & \text{if } t < 0.5 \\ E_\varepsilon c_1\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_1(e_1,t) - \nu_1(e_1) - s\right] + E_\varepsilon c_2[w_2\cdot q_2(e_2,t) - \nu_2(e_2) + s] & \text{if } t > 0.5. \end{cases} \tag{21}$$

Here, we have to consider all three cases. (i) If the individual decides to set $t = 0.5$, the problem is equivalent to SAVE. (ii) If the individual decides to shift into the same direction as predicted for SHIFT, he/she sets $t < 0.5$ and can also save (so the exact combination of s and t is not clear but the prediction for SHIFT would be a corner solution). (iii) The individual can also stay longer in shift 1 than predicted for SHIFT or as experimentally induced in SAVE and can then use savings to even out (expected) marginal consumption between the two shifts. In the following, we consider the FOCs for (ii) and (iii).

The four general FOCs for $t < 0.5$ are given by:

$$\frac{\partial E_\varepsilon C^{\text{SAVE\&SHIFT}}}{\partial e_1} = c_1'[w_1\cdot q_1(e_1,t) - \nu_1(e_1) - s]\left(w_1\frac{\partial q_1(e_1,t)}{\partial e_1} - \nu_1'(e_1)\right) = 0, \tag{22}$$

$$\frac{\partial E_\varepsilon C^{\text{SAVE\&SHIFT}}}{\partial e_2} = E_\varepsilon\left[c_2'\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right]\right.$$
$$\left.\times\left(\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)\frac{\partial q_2(e_2,t)}{\partial e_2} - \nu_2'(e_2)\right)\right] = 0, \tag{23}$$

$$\frac{\partial E_\varepsilon C^{\text{SAVE\&SHIFT}}}{\partial s} = -c_1'[w_1\cdot q_1(e_1,t) - \nu_1(e_1) - s] + E_\varepsilon c_2'\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right] = 0, \tag{24}$$

$$\frac{\partial E_\varepsilon C^{\text{SAVE\&SHIFT}}}{\partial t} = c_1'[w_1\cdot q_1(e_1,t) - \nu_1(e_1) - s]\cdot\frac{\partial q_1(e_1,t)}{\partial t} + E_\varepsilon\left[c_2'\left[\left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right]\cdot\right.$$
$$\left.\times\left(\left(\frac{-0.5}{(1-t)^2}w_1 + \frac{0.5}{(1-t)^2}w_2\right)q_2(e_2,t) + \left(\frac{0.5-t}{1-t}w_1 + \frac{0.5}{1-t}w_2\right)\frac{\partial q_2(e_2,t)}{\partial t}\right)\right] = 0. \tag{25}$$

Here, the FOC in Eq. (24) is equivalent to Eq. (16) in SAVE (only the wage terms in shift 2 are different due to the opportunity to determine the expected average shift wage in SHIFT). Relatedly, the FOC in Eq. (25) is equivalent to Eq. (20) in SHIFT (here the only difference is that the FOC in SAVE & SHIFT contains the s terms while the one in SHIFT does not). Abstracting from these two differences across the three settings, the FOCs related to savings in SAVE and SAVE & SHIFT and the FOCs related to shifting in SHIFT and SAVE & SHIFT are exactly the same. Saving and shifting are perfect substitutes.

For the sake of completeness, we also show the general FOCs for $t > 0.5$ (the differences to the case of $t < 0.5$ are due to the wage composition in the two shifts):

$$\frac{\partial E_\varepsilon C^{\text{SAVE\&SHIFT}}}{\partial e_1} = E_\varepsilon\left[c_1'\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_1(e_1,t) - \nu_1(e_1) - s\right]\left(\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)\frac{\partial q_1(e_1,t)}{\partial e_1} - \nu_1'(e_1)\right)\right] = 0, \tag{26}$$

[11] Or, put in another way: When adjusting t, the individual should also adjust effort in the two shifts. If he/she decides to stay longer in shift 1 by a certain ratio, effort in shift 1 should be increased by the same ratio.

Table 2
Parameters.

Functions	Parameters
Consumption function (Eq. (1))	$\eta = 7; \zeta = 4$
Cost function (Eq. (2))	$\varphi = 0.1;$
Wages	$w_1 = w = 100; w_2 = w \pm \varepsilon; \varepsilon = 80$

Source: Authors' calculations.

Table 3
Coefficients of the Estimated Production Function.

	α	β	γ	#obs.	R^2
All treatments, both shifts	14.423***	-0.002***	76.007***	1536	0.99
	(0.684)	(0.000)	(3.319)		
	[13.074, 15.772]	[-0.002, -0.001]	[69.461, 82.554]		

Notes: Cluster robust (subject level) standard errors are in parentheses, significance levels are * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 95%-confidence intervals in brackets. *Source:* Authors calculations.

Table 4
Rounded Unconditional Model Predictions.

	Optimal Choices/(Experimental Design Settings)				
Treatment	Effort Shift 1	Effort Shift 2	Savings s	Shifting t	Exp. Payoff in Euro
Base	25	17	(0)	(0.5000)	12.20
Save	25	19	1859	(0.5000)	13.12
Shift	22	22	(0)	0.3675	13.12
Save & Shift	22–28	16–22	0–3734	0.3675–0.7796	13.12

Source: Authors calculations.

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial e_2} = E_\varepsilon\left[c_2'[w_2 \cdot q_2(e_1,t) - \nu_2(e_2) + s]\left(w_2\frac{\partial q_2(e_2,t)}{\partial e_2} - \nu_2'(e_2)\right)\right] = 0, \tag{27}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial s} = E_\varepsilon\left[-c_1'\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_1(e_1,t) - \nu_1(e_1) - s\right] + c_2'[w_2 \cdot q_2(e_1,t) - \nu_2(e_2) + s]\right] = 0, \tag{28}$$

$$\begin{aligned}\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial t} &= E_\varepsilon\left[c_1'\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_1(e_1,t) - \nu_1(e_1) - s\right]\right.\\ &\quad \times \frac{\partial q_1(e_1,t)}{\partial t} + c_2'\left[\left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)q_2(e_2,t) - \nu_2(e_2) + s\right]\\ &\quad \left.\cdot\left(\left(\frac{-0.5}{t^2}w_1 + \frac{0.5}{t^2}w_2\right)q_2(e_2,t) + \left(\frac{0.5}{t}w_1 + \frac{t-0.5}{t}w_2\right)\frac{\partial q_2(e_2,t)}{\partial t}\right)\right] = 0.\end{aligned} \tag{29}$$

3.4. Point predictions & hypotheses

To derive point predictions for our treatments, we use the specifications and parameters introduced in Section 3.2 and an estimated production function (which we already base on observed experimental data). Table 2 summarizes the parameters used in the experiment.

The solution uses one single estimated production function for a representative subject in the form of Eqs. (3) and (4).[12] We obtain the results for all treatments and shifts as reported in Table 3. Despite being estimated for all subjects using all eight treatments/shifts, our estimation has a very good fit ($R^2 = 0.99$) due to the inclusion of the shifting parameter t.[13]

We use the parameters in Table 2 and the estimated coefficients of the production function in Table 3 to numerically solve the FOCs in Section 3.3 (and the appendix). The unconditional model predictions are shown in Table 4 (they are

[12] In the terms of our experimental design: We regress the number of balls caught in each shift on the number of movements according to the specifications in Eqs. (3) and (4) to estimate the coefficients α, β, and γ.

[13] In Table C.1 in the Appendix, we report estimations separately for different shifts and treatments. We find that these separate estimations are comparable to the one we report here. Almost all confidence intervals of the three variables overlap across treatments and shifts.

unconditional because all variables are optimally chosen; if, e.g. effort e_1 in Save was not at the unconditionally optimal level of 25, this would of course affect the optimal level of savings according to the FOC in Eq. (16)). Effort levels and savings in the experiments are discrete, thus we report the rounded values for e_1, e_2, and s and resulting expected payoffs. We can supply point predictions for Base, Save, and Shift.[14]

For Save & Shift, we show the ranges in which the solutions lie. The two extreme solutions are: (i) Ending shift 1 early (at $t = 0.3675$), with effort levels $e_1 = 22$ and $e_2 = 22$, and saving nothing $s = 0$. This solution is equivalent to Shift. (ii) Ending shift 1 late (at $t = 0.7796$), with effort levels $e_1 = 28$ and $e_2 = 16$, and saving $s = 3734$. Of course, there is a huge number of solutions between these two extremes (huge, not infinite, because we only allow for integer effort levels and savings). Besides the two mentioned extreme solutions, Save is one of the solutions included in Save & Shift. After all, saving and shifting are perfect substitutes (and all three intertemporal models achieve the same expected payoff).

Our hypotheses are based on the comparative statics predictions in Table 4.[15] With the first hypothesis, we examine if subjects react to the risky period 2 wage by adjusting their effort compared to when the wage is certain in period 1. This is a test of Jensen's inequality and it is best tested in Base and Save where subjects cannot determine the expected average shift wages by mixing the two period's wages (see the case of $t > 0.5$ in Eq. (6) and the case of $t < 0.5$ in Eq. (7)). The consequence of being able to determine the expected average shift wages is observed best by the prediction for Shift: subjects should exercise the same effort in both shifts, only that shift 2 is expected to be shorter than shift 1.

Hypothesis 1: *In* Base *and* Save, *subjects exercise less effort when the wage is uncertain (in shift 2) than when it is certain (in shift 1).*

Both the standard model and our extended model predict that individuals engage in income smoothing. With the second hypothesis, we test this prediction. Do subjects actually use the two precautionary channels when they only have either one of them available? With our experimental design, we can test this using the data from Save and Shift.

Hypothesis 2a *Subjects in* Save *use the savings channel and save a significant part of their income.*
Hypothesis 2b *Subjects in* Shift *end shift 1 early (and, thus, spend more time in shift 2).*

What happens in the situation when subjects are allowed to use both precautionary channels in comparison to the situations with only one? The next set of hypotheses examines whether the subjects substitute the two savings channels. Clearly, in Save & Shift, the complexity of the task increases as subjects have to deal with four decision variables available to them. We are interested in the subjects' behavior: Do our subjects actually substitute saving and shifting? If they can do so, we are also interested in their preferences: Will they choose one of the extreme solutions or a mix of the two?

Hypothesis 3a *Subjects' savings in* Save *are higher than in* Save & Shift.
Hypothesis 3b *Subjects' time in work-shift 1 in* Shift *is lower than in* Save & Shift.

Finally, we investigate, how well subjects perform using saving and shifting as channels for intertemporal substitution. Our static treatment Base provides a benchmark for no intertemporal substitution. We expect that subjects earn more when they have (one or both) precautionary channels at hand compared to the situation without any opportunity to smooth. A testable implication of the equivalence of saving and shifting is that if subjects use these channels as perfect substitutes, expected payoffs would not significantly differ across treatments.

Hypothesis 4 *Subjects' expected Euro payoffs in* Save, Shift, *and* Save & Shift *are higher than in* Base *and equal.*

4. Experimental design and procedures

Our experimental design follows our model. As we expect a high level of heterogeneity of productivity between the subjects, we use a within-subject design for our individual decision-making experiments. Before we describe the different stages of the experiment, we explain the real-effort task that resembles work in our experiments.

The task We use the ball-catching task introduced by Gächter et al. (2016). Fig. 3 shows an example screen of this task. In the ball-catching task, subjects are presented a rectangular box. Balls are hanging at the top of the box in four columns and a tray is positioned at the bottom of the box. As soon as subjects click the start button, balls fall down the screen in either of the four columns at a constant speed (probabilities are equal for the next ball to fall in any column). Subjects earn the piece-rate w_j within period j by catching balls with the tray (hence, the expected work-shift revenue is $Er_i = q_{i1} \times w_1 + E(q_{i2} \times w_2)$ with q_{ij} the number of caught balls in shift i and period j). To catch the balls, the subjects can move the tray from one column to the other by clicking two buttons under the rectangular box labeled LEFT and RIGHT.

[14] Second shift effort in Save is higher than in Base. In Save, savings shift the expected wage to a region in the consumption function with diminishing payoff to higher shift-income. This means that the instantaneous effect of risk on effort due to Jensen's inequality gets smaller compared to Base, since the point where marginal effort equals marginal costs is reached later when savings lift the bad wage draw than under the bad wage draw alone.

[15] Note the absence of precautionary effort: effort in the *first shift* in Save, where higher effort could be exerted for precautionary reasons, is identical (also before rounding) to the *first shift* in Base, where the wage is certain and any precautionary behavior is excluded.

Fig. 3. Example of a Translated Screenshot of the Ball Catching Task (with 'Shift Button at the Bottom)
Source: Authors' calculations.

Moving the tray is costly in monetary terms; this can be interpreted as the labor effort employed in a shift. e_i designates the number of movements in a shift.[16] To implement an increasing marginal cost of effort, we use the following unit cost function in each shift i: $\kappa(e_i + 1) = 0.1 \times (e_i)^2$ with $e_i + 1$ being the next movement and e_i the number of movements so far.[17] At the beginning of each work-shift, the unit cost function is reset, $e_i(0) = 0$. The total cost per shift is given by the sum of unit costs, $\nu_i(e_i) = \sum_{k=0}^{e_i} \kappa(k)$. Therefore, this task generates a tradeoff between the revenue from catching balls, r_i, and the total cost of effort, $\nu_i(e_i)$. The point earnings in any of the two shifts are then given by revenue minus cost, $y_i = r_i - \nu_i - s$, where s denotes savings. The euro earnings in each shift are calculated by $\text{Euro}_i = 4 \times [\ln(y_i) - 7]$ (i.e., the consumption function). The variables number of caught balls, unit cost of the next movement, total cost, point earnings per ball, and total point and euro earnings in the current work-shift are continuously updated on-screen during the task. Once the task is started by pressing the start button, it cannot be paused. When the work-shift ends (either by the computer or by the subjects choice), a feedback screen with the statistics mentioned before is shown.

Let us delve into the practical problem of determining the (optimal) effort level. Since balls fall at a constant speed in randomly determined columns, one might get a quick revenue increase from moving the tray into the columns containing balls, but then would not be any better off (as the cost for movements increases disproportionately which makes future movements very costly). This tradeoff means that on average (due to the randomly determined columns), there is an optimal number of moves given the (expected) piece-rate (which we derived in Section 3.4). This means that one is best off by exercising constant effort over time within a shift: neither letting the tray stay put in one column for a long time nor catching many balls in a short time span are good alternatives to "effort smoothing."[18]

Part 1 of the experiment: Trial periods During this part, we let subjects play three incentivized trial periods so they can familiarize themselves with the user interface and mechanics of the task (thereby we intend to ensure stability of the production function). Only one of the three trial periods is chosen randomly for payoff and feedback about the chosen period is only shown at the end of the experiment (feedback about the performance is always given during and summarized after

[16] In contrast to many other real-effort tasks designed to be tedious for the subjects to "bring the task more in line with what people consider labor (Charness and Kuhn 2011, pp. 243-244), the ball-catching task quantifies the cost of effort in monetary terms. Hence, we consider the ball-catching task ideal for our research questions: we need to have control over the subjects cost function. Even if subjects enjoy the ball-catching task, the cost of effort should keep them from exercising more effort than necessary.

[17] We round the unit costs up to one integer in order not to confuse subjects with the decimals.

[18] This can already be seen in Table3: both time and effort enter the estimated production function and the fit is very good.

performing the task).[19] In a first trial period, we deviate from the costly effort-incentive structure and make movements costless. We also abstract from the concave consumption function. Subjects are given 180 seconds to catch balls, with each caught ball generating earnings of 1 euro cent. There is no tradeoff between the returns from catching balls and the monetary costs of effort in this trial period. In the following two trial periods (and for the rest of the experiment), subjects work with the concave consumption function, the convex cost function, and the point earnings outlined before. In the second trial period, subjects work on the task and earn a certain wage, $w = 100$ for 180 seconds. In the third trial period, subjects work under uncertainty and either earn the low or the high wage, $w = 20$ or $w = 180$, with equal probability, for 180 seconds.

Part 2 of the experiment: Main treatments In Part 2, we conduct the four main treatments in the order in which we described them in Section 3. We considered randomizing the order of the four treatments between subjects. But by sticking to the order in Section 3, we gradually increase the level of difficulty. Thereby, we intend to limit our subjects confusion that could occur due to, e.g., taking both a shifting decision and then a saving decision in the first round.

In the instructions and on-screen we talk about four rounds, not about treatments. Here we will stick to the term 'treatments'. Each of the four treatments consists of two periods of 180 seconds each (the first one with the certain wage, the second with the uncertain wage) and two work-shifts (which are defined as the time where subjects work without a break on the task). Only one of the four treatments is chosen randomly for payoff. Feedback about the chosen treatment and the realized wage is only presented at the very end of the experiment (again, feedback about the performance is given continuously during and after performing the task).

Treatment Base This is the simplest treatment as subjects have neither the savings nor the time allocation option at their disposal. Subjects work on the task for two work-shifts that coincide with the periods (180 seconds). In the first work-shift, subjects earn the certain piece-rate $w_1 = 100$. In the second work-shift, they work under uncertainty and earn either the high rate, $w_2 = 180$, or the low rate, $w_2 = 20$. The instructions stress that the probability for the low or high rate is equal and independently drawn in each of the treatments.

Treatment Save This treatment differs from Base only in the savings decision. If subjects earned a positive euro amount in the first work-shift, they enter a screen where they can calculate the consequences of hypothetical saving decisions with a slider. They then enter the number of points they would like to save in a separate box. (The savings amount has to be non-negative, $s \geq 0$, and the highest amount that subjects can save is limited so that the euro earnings in work-shift 1 cannot become negative.) After that, they press the OK button and proceed to the second work-shift. The amount of points saved is then deducted from the point earnings of the first work-shift and added to the point earnings in the second work-shift. See Fig. J.1 in Section Appendix J of the Appendix for a screenshot of the savings screen.

Treatment Shift This treatment differs from Base in the time allocation between the two work-shifts. Subjects can divide the total time, $T = 360$ seconds, between the two work-shifts. This is implemented in the following way: In work-shift 1 subjects are shown a button that allows them to switch to work-shift 2 at any point of time (see Fig. 3 for a screenshot of a first work-shift with the switch button at the lower-left corner of the task screen). They then spend the time remaining of the initial 360 seconds in the second work-shift. As soon as subjects enter the second period, the low wages point revenue and euro earnings are displayed on the left-hand side of the task box, and the high wages on the right-hand side of the task box.

Treatment Save & Shift In this treatment, both the savings decision of Save and the time allocation of Shift are available to the subjects. First, subjects have to decide when to end work-shift 1. After being shown feedback on their outcomes in work-shift 1, subjects enter the savings screen where they can enter their savings decision.

Part 3 of the experiment: Elicitation of risk aversion and prudence To elicit the risk aversion and prudence of the subjects, we consecutively presented them with 12 binary choices between lotteries, as proposed by Noussair et al. (2014). Fig. J.2 in Section Appendix J of the Appendix shows an example screenshot. Due to the potentially very high payoff of up to 165 euros, each subject only had a 1 in 20 chance of being randomly selected to receive a monetary payment from Part 3 of the experiment (which lasted about five minutes).

Post-experimental questionnaire In the post-experimental questionnaire, we asked the subjects for their gender, age, field of study, their number of semesters at university (including undergraduate studies), and how strenuous they perceived the experiment. We also asked for a subjective self-assessment of their general level of risk aversion. Moreover, we asked whether subjects knew anybody who previously participated in this experiment and whether they paid attention to the low or to the high piece-rate in the periods where the rate was uncertain. Section Appendix E in the Appendix presents a summary of our sample and discusses it briefly.

Procedures and subjects Upon arrival at the laboratory, the subjects were seated in separate booths. Communication among subjects was prohibited. Then, the subjects received printed instructions which included tables with selected values and graphs of the cost and consumption functions. After reading the instructions, the subjects had to correctly answer a set of control questions to proceed.[20] The experiment was computerized. Only after the subjects completed the three parts of the experiment and answered the questionnaire, they received feedback about the outcomes of the experiment and their euro earnings. The payoff took place in a room separate from the other subjects.

[19] This is a common technique to avoid portfolio effects when subjects make multiple decisions. It also helps us to keep each decision salient by paying a high amount per decision. See Charness et al. (2016) for a discussion of paying one or few decisions vs. paying all.

[20] You can find a translation of the instructions, the supplied tables, and the control questions in Sections Appendix F, Appendix G, and Appendix H of the Appendix. The original instructions in German are available in Section Appendix I of the Appendix.

Table 5
Summary of data.

Treatment	BASE	SAVE	SHIFT	SAVE & SHIFT
Movements in Shift 1	32.71 [30.00] (18.44)	30.73 [30.00] (17.37)	27.64 [27.50] (17.15)	27.73 [27.00] (16.53)
Movements in Shift 2	26.54 [24.00] (17.53)	25.20 [24.00] (14.93)	26.52 [22.50] (21.60)	25.46 [22.00] (19.76)
Δ Movements (Shift 1-Shift 2)	6.18 [6.00] (0.80)	5.53 [6.00] (0.67)	1.12 [5.00] (1.52)	2.27 [5.00] (1.41)
Savings		2011.64 [2000.00] (1244.67)		1511.16 [1497.50] (1115.59)
Proportion With $s > 100$		0.90 [1.00] (0.31)		0.87 [1.00] (0.34)
Time Shift 1 in Seconds			165.66 [162.00] (70.54)	170.53 [181.00] (61.02)
Proportion With Work-Shift 1 Shorter than 180 Seconds			0.59 [1.00] (0.49)	0.47 [0.00] (0.50)
Expected Payoffs in Euros	8.76 [11.82] (9.82)	11.20 [12.69] (7.56)	9.85 [12.14] (7.00)	10.86 [12.72] (7.04)
Observations	192	192	192	192

Notes: Mean, median in square brackets, and standard deviation in parentheses. *Source:* Own calculations.

We conducted all experiments in PLEx, the Potsdam Laboratory for Economic Experiments at Universitaet Potsdam[21], in November and December 2017. All 192 subjects were students of Universitaet Potsdam and other nearby universities (Freie Universitaet Berlin, Filmuniversitaet Potsdam, and University of Applied Sciences Potsdam) and were 18 years or older. We invited subjects using ORSEE (Greiner 2015). We did not apply any exclusion criteria to the registered subjects in the database. Every subject participated only once. The experiments were run on z-Tree (Fischbacher 2007), in 19 sessions of 4 to 14 subjects (depending on enrollment to the experimental sessions and attendance of subjects). The laboratory sessions took about 90 minutes. On average, subjects earned about 15 euros (with a minimum of 0 euros and a maximum of 66.20 euros).

5. Results

5.1. Summary statistics and average treatment effects

Table 5 provides summary statistics of the data from the 192 subjects, separately for each of the treatments.

The average and median number of movements in shift 1 is greater than in shift 2 in all treatments (we report the tests of Hypotheses 1 here, using paired two-sided t-tests: they are highly significant in BASE ($p < .0001$) and SAVE ($p < .0001$), and not significant in SHIFT ($p = .4621$) and SAVE & SHIFT ($p = .1106$)). Savings are greater in SAVE than in SAVE & SHIFT. As predicted, we do not find evidence for precautionary effort: the difference between shift 1 effort in Save and Base in not significant ($p = .2798$, t-test). Relatedly, the proportion of subjects with savings larger than 100 points is very high (and slightly higher in SAVE than in SAVE & SHIFT).[22] Average time spent in work-shift 1 is smaller than 180 seconds in both treatments, indicating precautionary shifting. We can also see that a smaller fraction of subjects ended shift 1 early in SAVE & SHIFT compared to SHIFT.[23] Once the possibility of intertemporal substitution via savings was given, many subjects substituted finishing work-shift 1 early with savings. This is consistent with the model that indicates that shifting and saving

[21] Economic experiments are not subject to the universitys Institutional Review Board.

[22] We chose 100 points as the threshold to be far enough away from the zero-lower bound, but the results change very little if we use other thresholds.

[23] Interestingly, the difference of the average proportions across treatments is smaller for saving than for shifting. The share of savers in SAVE (89.58 percent) minus the share of savers in SAVE & SHIFT (86.98 percent) is smaller than the share of shifters in SAVE (58.85 percent) minus the share of shifters in SAVE & SHIFT (47.40 percent). The reduction of saving and shifting when the subjects have both channels is in line with our theory.

Table 6
Differences Across Treatments.

	Savings	Time Shift 1	Time Shift 1 ≤180	Income Cut	Income Cut≥0
Save minus Base	2011.64***			2011.88***	2011.88***
	(89.98)			(90.01)	(90.03)
Shift minus Base		-14.34***	-59.31***	934.84***	2182.15***
		(5.10)	(3.36)	(146.90)	(132.20)
Save & Shift minus Base	1511.16***	-9.47**	-57.98***	2117.63***	2671.91***
	(80.65)	(4.41)	(3.72)	(158.77)	(133.10)
Constant (Base)	0.00	180.00	180.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	576	576	397	768	665

Estimation Equation: Differences across treatments estimated using OLS. *Inference:* Cluster robust (individual level) standard errors are in parentheses, significance levels are * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Authors calculations.

are alternative channels for transferring resources between shifts. Table 5 also shows that expected payoffs are greatest in Save and smallest in Base, where neither saving nor shifting is allowed.

Result 1: *In* Base *and* Save*, the treatments with fixed work-shifts, subjects in the second shift exercised about 18 percent less effort than in the first shift. As predicted, Jensen's inequality holds. However, this result does not hold in the treatments with flexible work-time (effort in* Shift *is reduced by 4.1 percent, in* Save & Shift *by 8.2 percent, not significantly different from zero).*

Table 6 reports the findings for Hypotheses 2a and 2b. It shows the differences of the variables in Save, Shift, and Save & Shift from Base using OLS regressions (the mean in Base of the respective variable is equal to the constant in the regressions).

The first column considers savings and presents our evidence regarding the existence of precautionary saving (stated in Hypothesis 2a). We observe significant savings in Save. In Save & Shift, the savings coefficient is smaller than in Save, which suggests that some savings might have been substituted by shifting. Tests of proportions show that the lower bound of subjects with precautionary savings is 85 percent in Save and 82 percent in Save & Shift.[24]

Result 2a: *Subjects' savings in* Save *and* Save & Shift*are significantly different from zero. In* Save*, savings are strictly positive for at least 85 percent of subjects (and for 82 percent of subjects in* Save & Shift*) according to tests of proportions.*

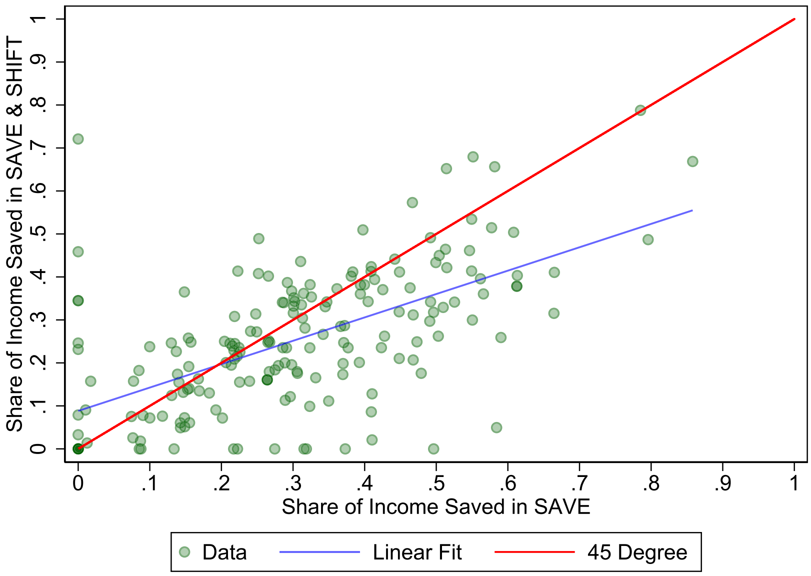
From the table, we can see that our subjects spent on average significantly less time in work-shift 1 in Shift (-14 seconds) and Save & Shift (-9 seconds) than in Base, supporting Hypothesis 2b. These averages mix subjects who saved and borrowed through shifting. Column 3 shows that shifting is quantitatively significant (on average -59 and -58 seconds) when we exclude subjects who spent more than 180 seconds in work shift 1 (and thus borrowed). This is an indication that subjects could treat saving and shifting as substitutes and that they combine these two ways of intertemporal consumption smoothing.

Result 2b: *On average, subjects in* Shift *end the first work-shift 14 seconds earlier (and in* Save & Shift *9 seconds earlier. In* Shift*, work-shift 1 is shorter than work-shift 2 for around 59 percent of the subjects. In* Save & Shift*, this share is lower with around 47 percent.*

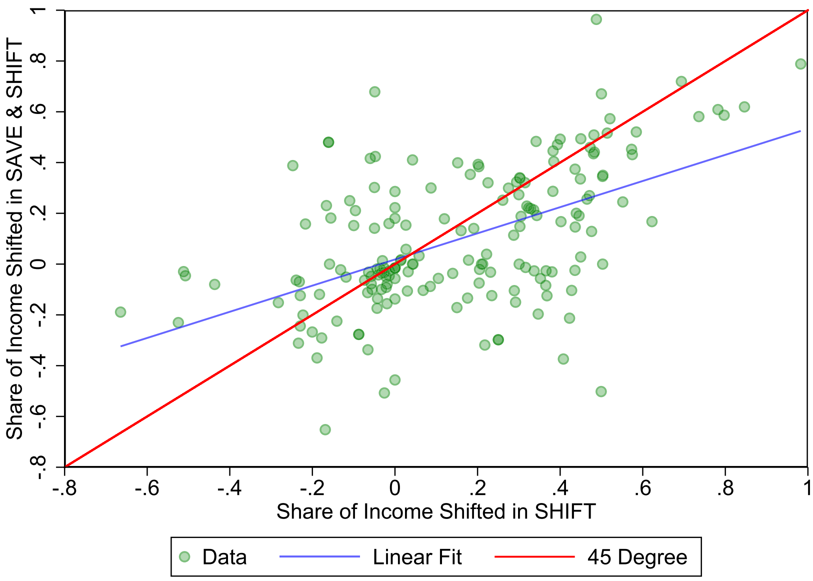
How can we compare precautionary shifting (which is measured in seconds) with precautionary savings (which is measured in points)? We subtract expected income in shift 1 and savings from income in period 1, which gives income cuts. These income cuts measure the difference between the benchmark level of income y_1 under certainty and expected income and savings in shift 1. If shifts and periods coincide, the only difference is income cuts due to savings; if savings are zero and shift 1 is shorter than period 1, this difference measures income cuts due to shifting. Since income cuts are measured in points, we can compare this measure across treatments. For income cuts in Shift, we calculate the difference of income in period 1 to income obtained in shift 1. Similarly, in Save & Shift, this difference minus the amount of savings gives total income cuts. The fourth column shows that income cuts just equal savings (up to minuscule precision error) from the first column in this case.

The theoretical model implies that optimal intertemporal substitution, i.e. income cuts, in Save and Save & Shift should be equal. When we consider the unrestricted sample, average income cuts in Shift are much lower than in Save and Save & Shift. In the next column, we exclude all subjects from the sample that did not save, i.e., who have negative income cuts. This shows that while in Save and Shift savings and shiftings were virtually perfectly substituted, in Save & Shift very strong income cuts take place. These findings indicate that the two different channels are not perfect substitutes. A possibly higher cognitive load when optimizing two different channels at once might cause difficulties for our subjects, resulting in behavior Save & Shift further from optimum than in Save.

[24] The test of proportions is conceptually very similar to a t-test. It tests hypotheses about proportions in a population. Tests of proportions show at the 5 percent-level that at least 85 percent in Save and 82 percent in Save & Shift save.



(a) Less Savings if Shifting is Allowed



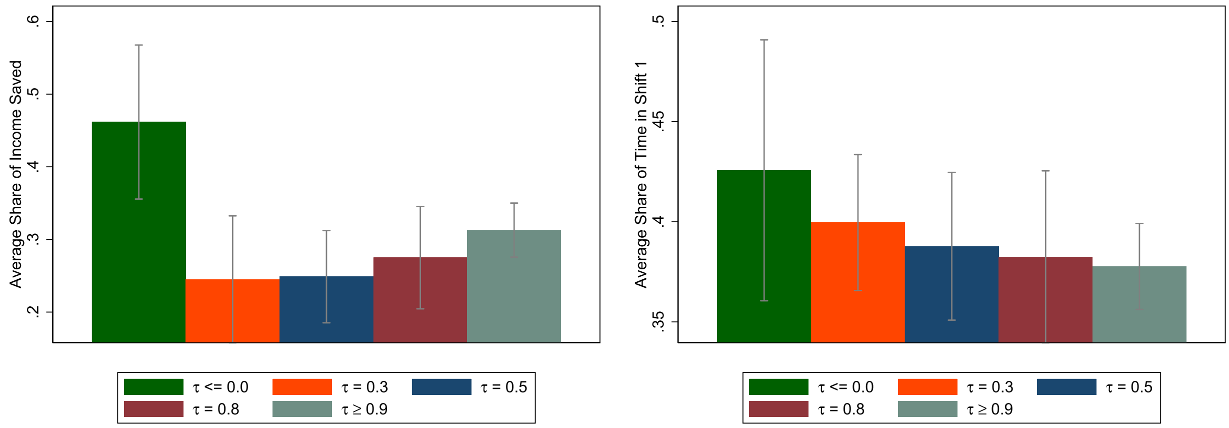
(b) Longer First Work-Shift if Saving Allowed

Fig. 4. Test of Hypothesis 3 *Source:* Authors' calculations.

5.2. Is shifting a substitute for saving?

In this section, we test whether and how subjects substitute saving for shifting. Fig. 4 presents visual evidence for how subjects substitute the two methods of intertemporal consumption smoothing. Fig. 4a plots the share of income saved in Save on the horizontal axis and the same figure from Save & Shift on the vertical axis. The linear regression line is flatter than the 45-degree line (slope 0.387 with a standard error of 0.034; pairwise correlation coefficient of the data points $\rho = 0.379$; $p < .0001$). This is consistent with the substitution of saving and shifting.

Fig. 4 b shows similar evidence for shifting in Shift and Save & Shift. Here the share of income *shifted* in Shift is presented on the horizontal axis and the same figure in Save & Shift on the vertical axis. Again, the regression line is flatter than the 45-degree line (slope 0.385 with a standard error of 0.023; pairwise correlation coefficient of the data points is $\rho = 0.524$; $p < .0001$). This finding is also in line with the substitution of saving and shifting. In Fig. 4b, we can visually



(a) Save (b) Shift

Fig. 5. Average Share of Income Saved and Time Spent in Shift 1 by τ

Notes: Sample means and 95%-confidence intervals based on heterogeneous risk preferences as defined in Table 9. Theory predicts that the share of income saved increases with higher risk aversion (τ) and prudence ($\tau + 1$). Equivalently, the share of time spent in shift 1 decreases with higher risk aversion and prudence. Fig. 5b is based on subjects who spent less than 180 and more than 100 seconds in shift 1, see Fig. D.2 in the Appendix for the full sample. *Source:* Authors' calculations.

Table 7
Differences Across Save.

	Savings	Time Shift 1	Time Shift 1 ≤180	Income Cut	Income Cut≥0
Save minus Save & Shift	500.48***			-105.75	-660.03***
	(82.17)			(153.68)	(144.43)
Shift minus Save & Shift		-4.88	-1.33	-1182.79***	-489.76***
		(4.70)	(3.48)	(153.83)	(146.11)
Constant (Save & Shift)	1511.16***	170.53***	122.02***	2117.63***	2671.91***
	(80.62)	(4.41)	(3.72)	(158.74)	(133.08)
Observations	384	384	205	576	473

Estimation Equation: Differences across treatments estimated using OLS. *Inference:* Cluster robust (individual level) standard errors are in parentheses, significance levels are * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Authors calculations.

identify subjects that replicate both restrictions of Base in both Shift and Save & Shift (resulting in the cluster around the 0 percent/0 percent point). These subjects seem to abstract from risk to simplify the intertemporal model.

Overall, a majority of 59.9 percent of subjects save in Shift, and 50 percent save in Save & Shift. The share of subjects that behave consistently across treatments and save in *both* Shift and Save & Shift is 41.1 percent. The share of subjects that behave consistently against the models' predictions is lower: 23.4 percent borrow in both treatments[25] One reason for this persistent behavior could be the cognitive load involved in making the shifting decision. However, since borrowing can be optimal in Save & Shift, this could also reflect following up with a deliberate choice rather than a persistent mistake. About 8.9 percent revise their choice to borrow in Shift and save in Save & Shift.

Table 7 is analogous to Table 6 but compares Save and Shift with Save & Shift. It shows that the difference of about 25 percent in savings between Save and Save & Shift is significantly different from zero. The point estimate for shifting in Shift is smaller than for Save & Shift, which again indicates substitution. We cannot reject that the amount of shifting is the same in these treatments, though. In the third column we restrict the sample to subjects who ended work-shift 1 on or before 180 seconds. We see that the difference between Shift and Save & Shift is also insignificant in the restricted sample. Compared to Save & Shift, income cuts in Save do not significantly differ in the full sample, but they do in Shift (where subjects cut their consumption significantly less than in Save & Shift). Focusing on those with positive or zero income cuts, the difference becomes significantly negative. This difference is similar to the difference between Shift and Save & Shift. This implies that the large difference from the entire sample is due to subjects who do not behave according to the theory of precautionary saving.

Result 3a: *When subjects can only save (but not shift), they save more compared to the situation where they can also shift.*

Result 3b: *Subjects' time in work-shift 1 in Save & Shift is not significantly different from the time in Shift.*

[25] In Shift 32.3 percent borrow, and 42.2 percent in Save & Shift.

Table 8
OLS regression of euro earnings on treatment dummies.

	Full Sample			Income Cut≥0		
Euro earnings	Expected	Ex-Post Low	Ex-Post High	Expected	Ex-Post Low	Ex-Post High
Base (Constant)	$8.76^{***,a,c}$	$2.38^{***,a,b,c}$	15.14^{***}	$8.76^{***,a,b,c}$	$2.38^{***,a,c}$	15.14^{***}
	(0.71)	(0.84)	(0.67)	(0.71)	(0.84)	(0.67)
Save-Dummy	$+2.43^{***,b}$	$+5.01^{***,b}$	-0.14	$+2.43^{***}$	$+5.01^{***}$	-0.14
	(0.41)	(0.58)	(0.37)	(0.41)	(0.58)	(0.37)
Shift-Dummy	$+1.09^{**,a,c}$	$+2.79^{***,a,c}$	-0.61	$+1.48^{**}$	$+3.43^{***,c}$	-0.46
	(0.52)	(0.68)	(0.52)	(0.63)	(0.84)	(0.61)
Save & Shift-Dummy	$+2.09^{***,b}$	$+4.69^{***,b}$	-0.51	$+2.40^{***}$	$+5.06^{***,b}$	-0.25
	(0.54)	(0.68)	(0.53)	(0.61)	(0.74)	(0.61)
Observations	768	768	768	665	665	665

Robust standard errors clustered at subject level. Significantly different from zero at the 1%-level: ***, 5%-level: **. Significantly different from Saves coefficient at the 1%-level: [a], from Shifts: [b], from Save & Shifts: [c]. *Source:* Own calculations.

Table 9
Heterogeneity in Risk Preferences.

Lottery	Switch at safe	τ	# obs.	Share
$w = 35; \varepsilon = 30; p = 1/2$	≥ 35 Euro	$\tau \leq 0.0$	14	7.29
$w = 35; \varepsilon = 30; p = 1/2$	30 Euro	$\tau = 0.3$	18	9.38
$w = 35; \varepsilon = 30; p = 1/2$	25 Euro	$\tau = 0.5$	30	15.63
$w = 35; \varepsilon = 30; p = 1/2$	20 Euro	$\tau = 0.8$	21	10.94
$w = 35; \varepsilon = 30; p = 1/2$	lottery never chosen	$\tau \geq 0.9$	81	42.19
$w = 35; \varepsilon = 30; p = 1/2$	multiple		28	14.58

Notes: Subjects were presented with one choice at a time between a safe amount of 20, 25, 30, 35, and 40 Euro (right screen) and a lottery (left screen). The lotteries were equiprobable and all randomizations were conducted by the computer. The five choices measuring risk aversion were ordered, such that the certain payoff increased monotonically. 5 subjects switched at 40 and 9 at 35 Euro, aggregated in the first row. τ is determined by the switching point implied by the payoff function in Eq. (1). Appendix E provides additional details. *Source:* Own calculations.

Taken together, our results from this and the previous section provide evidence that shifting and saving are indeed substitutes, though not for all subjects. If they were *perfect* substitutes, the average earnings would be identical across Save, Shift, and Save & Shift. Do expected euro earnings differ depending on which choices are available? To answer this question (Hypothesis 4), we conduct OLS regressions of expected euro earnings (euro earnings for low and high wages, weighted with equal probability), euro earnings if the low wage is realized, and euro earnings if the high wage is realized on treatment dummies (where Base serves as the baseline). Table 8 shows the results. First, we consider all observations. In the first column, we observe that subjects in Save, Shift, and Save & Shift earn significantly more than in Base (before knowing which of the two states of the world occurs). When we compare the earning differences in Save, Shift, and Save & Shift, we see that earnings in Save and Save & Shift are not significantly different from one another and that earnings in Shift are significantly lower than in Save and Save & Shift.

The second and third columns show how euro earnings are affected ex-post. In case the 'bad' state of the world occurs, in column 2 the same pattern as under uncertainty emerges (only with higher magnitudes of the constant and the treatment dummies coefficients). This means that subjects use saving and shifting as precautionary measures against a 'rainy day but not as a perfect substitute for one another.

In column 3 we can see how much income the subjects on average give up in case they do not need to insure, i.e., the 'good' state of the world occurs. None of the coefficients for Save, Shift, and Save & Shift is significantly different from zero: hence, the price subjects pay for their precautionary behavior is rather low compared to the potential benefits. Our results show that more flexibility does not necessarily lead to better outcomes. In fact, subjects attained the highest payoffs in Save, where they did not need to make a shifting decision while working on the ball-catching task but had time to contemplate several possible saving choices (on an extra screen).

Finally, we consider the last three columns where we restrict the sample to subjects who behaved in line with theory and decided not to borrow in Shift and Save & Shift. Here, the coefficients for expected euro earnings are not significantly different across Save, Shift, and Save & Shift. Some coefficients for the 'good' and 'bad' state of the world in columns 5 and 6 are larger. These subjects are indeed better in using precautionary measures.

Result 4: *Expected payoffs are significantly higher if either shifting or saving is allowed than when neither is allowed. We also observe an ordering of expected payoffs where theory does not predict one: Expected payoffs are significantly lower if only shifting is allowed compared to the case where either only saving is allowed or both saving and shifting are allowed. Thus, while saving and shifting are substitutes, they are not perfect substitutes.*

5.3. Classification of behavioral strategies

5.3.1. Heterogeneity in risk preferences

The results in the previous section focused on the comparative statics in the different treatments and showed substantial heterogeneity in choices, despite the fact that observed behavior has the predicted direction. In this section, we explore the role of differences in subjects' risk preferences and whether there are different behavioral types observable in our data.[26] Although we induced risk preferences with the payoff function (see Eq. (1) in Section 3.2), the optimal strategy may depend on a subject's own homegrown preferences and previous choices. We are interested in deviations from optimal choices taking this heterogeneity into account. To this end, we calculate the optimal shares of income saved in Save and the optimal shares of time spent in shift 1 in Shift, conditional on individual risk preferences and effort in shift 1 and compare them with observed behavior.

We elicited risk preferences after the experiment using choices between a safe amount and lotteries.[27] Table 9 reports the observed distribution. Forty-two percent of subjects can be classified with a τ of 0.9, which is close to the $\tau \to 1$ induced by the log payoff function. Eleven percent can be assigned $\tau = 0.8$, 16 percent $\tau = 0.5$, nine percent $\tau = 0.3$, and seven percent as risk neutral with $\tau \leq 0$. Table E.2 in the Appendix shows that this is in line with the subjective self-assessment of subjects on a 11-point Likert scale (which was part of the questionnaire).

Differences in saving and shifting might be the result of differences in individual risk preferences. Using Eq. (1), we can assign the coefficient of relative risk aversion τ and the corresponding coefficient of relative prudence $\tau + 1$ consistent with each subject's unique switching point from the lottery to the safe amount.[28] Theory predicts that the share of income saved increases with higher risk aversion (τ) and prudence ($\tau + 1$).[29] Equivalently, the share of time spent in shift 1 decreases with higher risk aversion and prudence. Fig. 5 shows that observed behavior in Save and Shift is in line with this prediction: average savings shares increase monotonically with τ, and average shifting shares decrease monotonically with τ, except for the subjects classified as risk neutral, whose optimal savings should be zero.[30] For the other groups, the differences between the groups are not statistically different (note the relatively small number of observations for the different degrees of τ).

5.3.2. A Random Behavior model

To investigate deviations from optimal behavior, we analyze the data from the econometric perspective of a random behavior model (see Moffatt, 2015, section 8, and Engel, 2020, for an introduction to the method and discussion, and Gerhard et al., 2018, for a recent application to saving behavior). We assume that individuals are of three different behavioral types (who deviate from different optima implied by alternative behavioral strategies). These types are also called latent classes as their proportions in the population are not known. We are interested whether significant shares of subjects can be assigned to behavioral strategies other than that described by the model in Section 3.3. We focus on the optimal share of income saved (s/y) or the share of time spent in shift 1 (t) in treatments Save and Shift summarized as λ_g for each of the following three types $g = 1, 2, 3$:

1. **Hand-to-mouth** ($g = 1$): Subjective expectations $\hat{E}[w_2] = w$ imply a saving rate of $(s/y) = 0\%$ and a share of time spent in shift 1 of $t = 50\%$,
2. **Optimizer** ($g = 2$): Expected utility implies expectations about wage in period 2 $E[w_2] = p \times (w + \varepsilon) + (1 - p) \times (w - \varepsilon)$ imply $(s/y) = 27.4\%$ and $t = 36.75\%$,
3. **Risk pessimist** ($g = 3$): Subjective expectations $\hat{E}[w_2] = w - \varepsilon$ imply $(s/y) = 41.2\%$ and $t = 30\%$.

From theory, we know that an optimizer should save $(s/y) = 27.4$ percent of her income with $e_1 = 25$ and log payoff. The other two types deviate from this prediction. Hand-to-mouth individuals simplify the model and assume that the wage in period 2 is certain and equal to period 1 wage. Hence, there is no reason for them to save and/or shift at all. Risk pessimists assume that they end up in the bad state of the world in period 2 and that the low wage realizes. Increasing τ goes in this direction. For example, $\lambda_3(s/y|\tau = 1.5, e_1 = 25) = 30.0\%$. In the extreme case, however, they would just focus on the bad outcome (assuming it occurs with probability $p = 1$) and thus save 41.2 percent with $e_1 = 25$ with any $\tau > 0$. With these types, we have one behavioral type with a lower savings/shifting rate than optimal under expected utility, and one type with a higher one.

Heterogeneity in savings and shifting can also occur because of previously non-optimal decisions in the experiment. Specifically, (conditionally optimal) saving and shifting depend on how much income has been earned in the first shift,

[26] We are grateful to a referee for suggesting the inclusion of this topic.

[27] These choices were incentivized with relatively high payoffs of up to 165 euros. See Part 3 of the experiment in Section 4 for details.

[28] This means that we *replace* the induced risk aversion coefficient in the payoff function with the elicited risk aversion coefficient. We chose our approach because of its simplicity. There are, of course, other ways of implementing homegrown risk preferences into the optimization task, e.g. (i) assuming that each subject uses an additional utility function on top of the complete two-shift optimization problem, or (ii) assuming that each subject uses an additional utility function on top of each of the two shifts separately.

[29] This is easy to see from the Euler equation (Eq. (16)), which can be written in treatment Save as $c'(y_1) = E_\varepsilon[c'(y_2)]$ or $c'(\tilde{y}_1 - s) = E_\varepsilon[c'(\tilde{y}_2 + s)]$. With the general CRRA payoff function it is clear from $(\tilde{y}_1 - s)^{-\tau} = E_\varepsilon[(\tilde{y}_2 + s)^{-\tau}]$ that s increases in τ. For instance, if $\tau = -1$, $s = 1/2(\tilde{y}_1 - E_\varepsilon[\tilde{y}_2]) = 0$, and if $\tau = 1/2$, s is the positive solution to $1/\sqrt{\tilde{y}_1 - s} = E_\varepsilon[1/\sqrt{\tilde{y}_2 + s}]$, and for $\tau \to 1$ the solution is as shown in Section 3.4.

[30] Since all risk neutral subjects chose substantial savings, it is possible that they followed the induced payoff function and stated their general risk preferences outside of the experiment.

Table 10
Estimated Probabilities for Types.

	Static Model	Intertemporal Models	
	(1) Hand-to-Mouth	(2) Optimizer	(3) Risk Pessimist
SAVE			
Probability π_g	0.058	0.612	0.330
	(0.021)	(0.092)	(0.091)
SHIFT			
Probability π_g	0.147	0.682	0.171
	(0.060)	(0.081)	(0.051)

Notes: Classification probabilities estimated with finite mixture models for three behavioral strategies: (1) *Hand-to-Mouth*, where optimal saving rate is zero and optimal share of time spent in shift 1 is 1/2. (2) *Optimizer*, where optimal saving rate is 27.4% and the share of time spent in shift 1 is 36.8% based on expected utility. (3) *Risk pessimist*, where optimal saving rate is 41.2% and the share of time spent in shift 1 is 30% based on ignoring the positive outcome. Standard errors clustered at the subject level obtained with the delta-method in parentheses. *Source:* Authors' calculations.

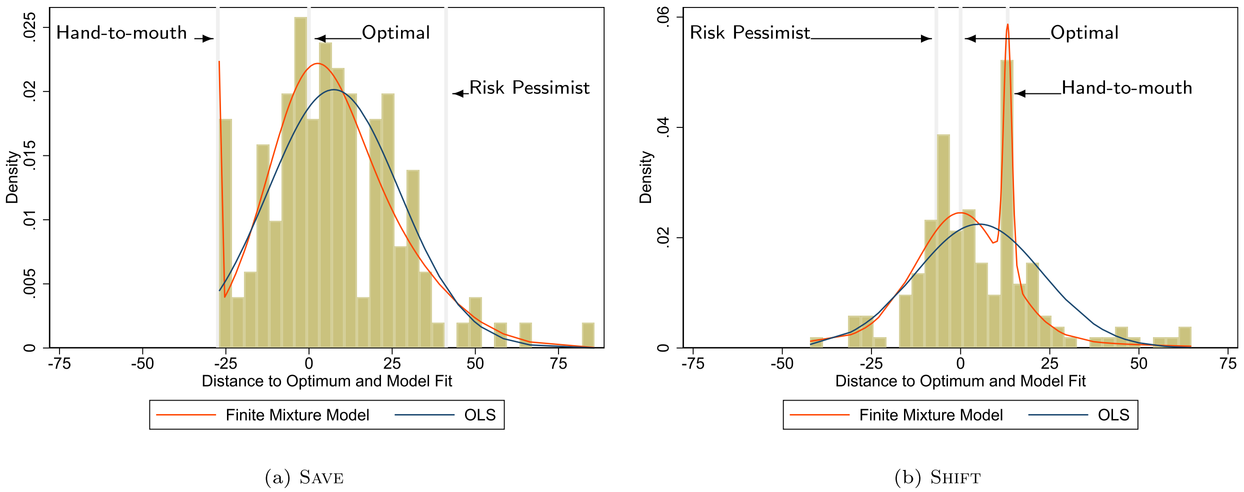


Fig. 6. Fit of Finite Mixture Models and OLS *Notes:* The histogram of the distance to optimal share of income saved and optimal share of time spent in shift 1 (in percentage points) is shown in yellow bars, blue lines represent the fit of an OLS model and red lines of finite mixture models. Gray lines show optimal behavior (distance to optimum is 0 percent), risk pessimist behavior (distance to optimum is +13.8 and -6.8 percentage points in SAVE and SHIFT, respectively), and hand-to-mouth behavior (distance to optimum is -27.4 and +13.2 percentage points). *Source:* Authors' calculations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

which depends on the choice of effort in the first shift (see the FOCs shown in Section 3.3). To take this into account, we calculate conditional optima that vary with τ and e_1.[31]

In our data set, we define d_i as dependent variable. It is calculated as the difference of individual i's choice from the conditional optimum of optimizers λ_2^{τ,e_1}. For treatment SAVE, $d_i = s_i/y_i - \lambda_2^{\tau,e_1}$, that is, the deviation of the saving rate from the optimal share given τ and e_1. Similarly, in treatment SHIFT, $d_i = t_i - \lambda_2^{\tau,e_1}$, which is the deviation of the share of time spent in shift 1 from the optimal share given τ and e_1. In a random behavior model, actual behavior may or may not coincide with optimal behavior because subjects systematically follow different behavioral strategies and, for each of the strategies, due to random optimization errors. We assume that the optimization errors ϵ_i are independent and normally distributed with variance $\sigma^2_{\epsilon,g}$.[32] With these assumptions, we can obtain estimates for the proportions π_1, π_2, π_3 of subjects following behavioral strategies $g = 1, 2, 3$ and for $\sigma^2_{\epsilon,g}$ as a mixture of the joint density functions for each type using the maximum likelihood method.

Table 10 reports the estimated shares of subjects in each of three types.[33] The hand-to-mouth subjects can be captured and range from 5.8 to 14.7 percent of all subjects in SAVE and SHIFT. The optimizer type captures from 61.2 to 68.2 percent of all subjects. Finally, 33.0 and 17.1 percent of the subjects are classified as risk pessimists (who oversave). This is consistent with our results in Fig. 4a, where we found substantial oversaving. Finally, we compare the finite mixture model approach with an OLS model in Fig. 6. We predict the density of this OLS model with only one class and a mixture density from the finite mixture model.

[31] We obtain numerical solutions of the model for $\tau \in \{-0.4, 0.0, 0.3, 0.5, 0.8, 0.9\}$ and $e_1 \in \{1, \ldots, 40\}$.

[32] That is $d_i - \lambda_g = \epsilon_i \sim N(0, \sigma^2_{\epsilon,g})$.

[33] Section Appendix B provides details on the estimation procedure.

Clearly, the deviations are concentrated around the conditional optimum both in the left-hand graph for Save and in the right-hand graph for Shift.[34] There is also clear evidence for hand-to-mouth behavior in both figures. The finite mixture model provides a better fit than the OLS model, since the OLS model misses the hand-to-mouth behavior (indicated by the left-most gray vertical line in the left-hand graph and the right-most gray vertical line in the right-hand graph). Oversavers, i.e. risk pessimists, contribute to the better fit since their shares are significantly different from zero (see Table 10) and the predicted distributions are appear skewed (though not clearly trimodal as our behavioral theory suggests).

The key conclusion from this evidence is that both empirical and theoretical economists need to explicitly take into account heterogeneity in behavioral strategies. Otherwise, e.g., estimates of the willingness to pay for flexible work arrangements will be biased.

Result 5: *A random behavior model of deviations from optimal saving and shifting shows that the behavior of more than 61 percent of subjects can be classified as consistent with our model, and that significant proportions of choices can be explained by hand-to-mouth behavior and risk pessimism.*

6. Conclusion

In this study, we present a two-period model with wage uncertainty. Our innovation is that we give individuals the opportunity to smooth consumption by allocating time between periods. This new channel seems to become increasingly important, as indicated by the emergence of the so-called gig economy. We use this model to compare four scenarios that individuals might face by turning on and off our new shifting channel and the well-established saving channel. We derive four hypotheses that we test in laboratory experiments. A novel feature of our consumption/saving experiments is that we tie them to a real-effort style task. This extends previous experiments by introducing an endowment effect, since subjects decide over own earnings rather than randomly drawn income. The real-effort style task is a prerequisite for shifting, because effort is exerted over a period of time that can be spent in a way that is equivalent to saving.

We test whether the subjects in our experiments behave according to theory when given either the saving or the shifting opportunity and cannot reject this in our first two hypotheses. Our subjects respond to wage uncertainty by adjusting their effort level, and they smooth via savings and shiftings. These findings complement empirical studies that did not find that savings adjust to income uncertainty (e.g., Fulford 2015). We report an asymmetry regarding the substitution of saving and shifting. We find that subjects save less when they can both save and shift. However, they do not significantly reduce their shifting in the case when they have both precautionary channels available in comparison to the situation where they can only shift. We also report an ordering of expected euro earnings in the three intertemporal treatments: they are highest in Save and lowest in Shift. Thus, in our experiments, saving and shifting are not *perfect* substitutes. When we examine the heterogeneity of our data, we find that homegrown risk preferences push precautionary behavior in the predicted direction. We can also find that behavioral types with other motivations than expected utility maximization can be identified in our data (namely, risk pessimists and hand-to-mouth consumers).

What are the limitations of our study? We see two important points that are worth mentioning. First, the borrowing constraint in Save might influence behavior in subsequent treatments (it might, e.g., set an anchor for the behavior in Save & Shift). Future experimental studies could abstract from this borrowing constraint. This, however, might be easier to implement in experiments without a real-effort style task, since with a stochastic income-generating process it is relatively straightforward to include a high enough minimum income that allows to pay back loans. In addition, optimal shifting behavior is not trivial and people in general might be more familiar with saving than with the allocation of work-time. As subjects had to decide when to switch while working on the task, this might be associated with a higher cognitive load than the savings decision. This cognitive load might lead to more mistakes when shifting. Already Camerer et al. (1997) reported that the cab drivers in their study had problems intertemporally substituting labor and leisure across multiple days (and especially inexperienced cab drivers). All subjects in our experiment experience each of the four treatments only once. There is evidence that experience reduces mistakes in savings experiments (Ballinger et al. 2003; Brown et al. 2009). Future work could examine if repeatedly working under flexible work-time conditions also reduces deviations from optimal behavior. The fact that the introduction of another precautionary channel does not enhance outcomes as much as predicted might be mitigated by the lack of opportunity to learn.

What are the key messages of our study for future research? Our model presents a first attempt to model shifting and presents theoretical results regarding the equivalence of saving and shifting. This suggests that future research examining precautionary savings should also account for the possibility that individuals may use precautionary channels other than saving. Our empirical evidence shows that risk aversion, prudence, and behavioral strategies other than expected utility maximization also play an important role. The inclusion of good measures of risk aversion *and* prudence would help quantifying the importance of precautionary saving decisions. We show that (subjective) expectations about wages and wage risk play an important role as well and need to be included in surveys specifically to identify motives for precautionary behavior and those from other strategies than expected utility maximization. Lab experiments provide a relatively clean way to test models—and still motivations from outside the lab play a role when subjects take their decisions. We surmise that these

[34] Fig. D.1 in the Appendix shows the corresponding figures for unconditional optima.

motivations are even more important in studies using observational data and therefore a fruitful avenue for new insights on consumption/saving behavior.

Declaration of Competing Interest

None.

Appendix A

A1. Additional optimality conditions

A1.1. Base

$$\frac{\partial E_\varepsilon C^{\text{Base}}}{\partial e_1} = \frac{\zeta\left(\frac{\phi e_1(2e_1+1)}{6} - w_1\left(\beta e_1 + \frac{\alpha}{4\sqrt{e_1}}\right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3}\right)}{\eta - \frac{w_1}{2}\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} = 0, \tag{A.1}$$

$$\frac{\partial E_\varepsilon C^{\text{Base}}}{\partial e_2} = E_\varepsilon\left[\frac{\zeta\left(\frac{\phi e_2(2e_2+1)}{6} - w_2\left(\beta e_2 + \frac{\alpha}{4\sqrt{e_2}}\right) + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3}\right)}{\eta - \frac{w_2}{2}\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0. \tag{A.2}$$

A1.2. Save

$$\frac{\partial E_\varepsilon C^{\text{Save}}}{\partial e_1} = \frac{\zeta\left(\frac{\phi e_1(2e_1+1)}{6} - w_1\left(\beta e_1 + \frac{\alpha}{4\sqrt{e_1}}\right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3}\right)}{\eta + s - \frac{w_1}{2}\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} = 0, \tag{A.3}$$

$$\frac{\partial E_\varepsilon C^{\text{Save}}}{\partial e_2} = E_\varepsilon\left[\frac{\zeta\left(\frac{\phi e_2(2e_2+1)}{6} - w_2\left(\beta e_2 + \frac{\alpha}{4\sqrt{e_2}}\right) + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3}\right)}{\eta - s - \frac{w_2}{2}\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0, \tag{A.4}$$

$$\begin{aligned}\frac{\partial E_\varepsilon C^{\text{Save}}}{\partial s} &= \frac{\zeta}{\eta + s - \frac{w_1}{2}\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} \\ &\quad - E_\varepsilon\left[\frac{\zeta}{\eta - s - \frac{w_2}{2}\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0.\end{aligned} \tag{A.5}$$

A1.3. Shift

For $t < 0.5$:

$$\frac{\partial E_\varepsilon C^{\text{Shift}}}{\partial e_1} = \frac{\zeta\left(\frac{\phi e_1(2e_1+1)}{6} - w_1 t\left(\beta e_1 + \frac{\alpha}{4\sqrt{e_1}}\right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3}\right)}{\eta - t w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} = 0, \tag{A.6}$$

$$\frac{\partial E_\varepsilon C^{\text{Shift}}}{\partial e_2} = E_\varepsilon\left[\frac{\zeta\left(\frac{\phi e_2(2e_2+1)}{6} - \left(\frac{w_2}{2} - w_1(t-0.5)\right)\left(\frac{\alpha}{2\sqrt{e_2}} + \beta e_2\right) + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3}\right)}{\eta - \left(\frac{w_2}{2} - (t-0.5)w_1\right)\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0, \tag{A.7}$$

$$\frac{\partial E_\varepsilon C^{\text{Shift}}}{\partial t} = E_\varepsilon\left[\frac{\zeta w_1\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right)}{\eta - \left(\frac{w_2}{2} - (t-0.5)w_1\right)\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}} - \frac{\zeta w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right)}{\eta - t w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}}\right] = 0. \tag{A.8}$$

A1.4. Save & shift

For $t < 0.5$:

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial e_1} = \frac{\zeta\left(\frac{\phi e_1(2e_1+1)}{6} - w_1 t\left(2\beta e_1 + \frac{\alpha}{2\sqrt{e_1}}\right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3}\right)}{\eta + s - t w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} = 0, \tag{A.9}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial e_2} = E_\varepsilon\left[\frac{\zeta\left(\frac{\phi e_2(2e_2+1)}{6} - \left(\frac{w_2}{2} - w_1(t-0.5)\right)\left(\frac{\alpha}{2\sqrt{e_2}} + 2\beta e_2\right) + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3}\right)}{\eta - s - \left(\frac{w_2}{2} - (t-0.5)w_1\right)\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0, \tag{A.10}$$

$$\begin{aligned}\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial s} &= \frac{\zeta}{\eta + s - t w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} \\ &\quad - E_\varepsilon\left[\frac{\zeta}{\eta - s - \left(\frac{w_2}{2} - (t-0.5)w_1\right)\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0,\end{aligned} \tag{A.11}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial t} = E_\varepsilon\left[\frac{\zeta w_1\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right)}{\eta - s - \left(\frac{w_2}{2} - (t-0.5)w_1\right)\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}} - \frac{\zeta w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right)}{\eta + s - t w_1\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}}\right] = 0. \tag{A.12}$$

For $t > 0.5$:

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial e_1} = E_\varepsilon\left[\frac{\zeta\left(\frac{\phi e_1(2e_1+1)}{6} - \left(\frac{w_1}{2} + (t-0.5)w_2\right)\left(2\beta e_1 + \frac{\alpha}{2\sqrt{e_1}}\right) + \frac{\phi(2e_1+1)(e_1+1)}{6} + \frac{\phi e_1(e_1+1)}{3}\right)}{\eta + s - \left(\frac{w_1}{2} + (t-0.5)w_2\right)\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}}\right] = 0, \tag{A.13}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial e_2} = E_\varepsilon\left[\frac{\zeta\left((t-1)w_2\left(\frac{\alpha}{2\sqrt{e_2}} + 2\beta e_2\right) + \frac{\phi e_2(2e_2+1)}{6} + \frac{\phi(2e_2+1)(e_2+1)}{6} + \frac{\phi e_2(e_2+1)}{3}\right)}{\eta - s + (t-1)w_2\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0, \tag{A.14}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial s} = E_\varepsilon\left[\frac{\zeta}{\eta + s - \left(\frac{w_1}{2} + (t-0.5)w_2\right)\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} - \frac{\zeta}{\eta - s - (t-1)w_2\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0, \tag{A.15}$$

$$\frac{\partial E_\varepsilon C^{\text{Save\&Shift}}}{\partial t} = E_\varepsilon\left[\frac{\zeta w_2\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right)}{\eta + s - \left(\frac{w_1}{2} + (t-0.5)w_2\right)\left(\alpha\sqrt{e_1} + \beta(e_1)^2 + \gamma\right) + \frac{\phi e_1(2e_1+1)(e_1+1)}{6}} - \frac{\zeta w_2\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right)}{\eta - s + (t-1)w_2\left(\alpha\sqrt{e_2} + \beta(e_2)^2 + \gamma\right) + \frac{\phi e_2(2e_2+1)(e_2+1)}{6}}\right] = 0. \tag{A.16}$$

Appendix B. The Finite Mixture Likelihood Function

The random behavior model specifies the deterministic variation in behavior as optimal choice λ_g for each behavioral strategy g. The non-deterministic variation in behavior is explained by the independent and identically distributed mean-zero error ϵ_i, where each type has its own variance $\sigma^2_{\epsilon,g}$.

Using this specification with a finite mixture model allows for consistent estimates of the proportions π_1, π_2, π_3 of the population who belong to a given type. Since this model is probabilistic, types may overlap (there are probabilities for any observation that it belongs to any of the three behavioral types). Thus, the model combines conditional probability density functions f_1, f_2, f_3 for the response of the respective type. The density of the three-component mixture model consists of the proportion-weighted density functions of the three types:

$$f(\epsilon_i|\pi_g, \sigma^2_{\epsilon,g}) = \sum_{g=1}^{3} \pi_g f_g(\epsilon_i|\sigma^2_{\epsilon,g}), \tag{B.17}$$

where $0 \le \pi_g \le 1$ are the proportions of the three types in the populations (with $\sum_{g=1}^{3} \pi_g = 1$). The sum of the probability-weighted conditional likelihoods from each type is optimized with maximum likelihood methods with a multinomial logistic distribution for the probabilities for the latent classes.

For the hand-to-mouth type, we assume $\epsilon_i = 0$ and, thus, a variance of zero. We estimate the following individual likelihood function, where ϕ is the probability density function of the normal distribution and the predicted probability for type g is given by π_g:

$$L(\pi_1, \pi_2, \pi_3, \sigma^2_{\epsilon,g}) = \pi_1 \mathbb{1}_{\{d_i=\lambda_1\}} + (1-\pi_1)\mathbb{1}_{\{d_i\neq\lambda_1\}}\left\{\sum_{g=2}^{3} \pi_g\left[\frac{1}{\sigma_{\epsilon,g}}\phi\left(\frac{d_i-\lambda_g}{\sigma_{\epsilon,g}}\right)\right]\right\}. \tag{B.18}$$

Appendix C. Additional Tables

Table C.1
Coefficients of Estimated Production Functions, by Treatment and Shift.

	α		β		γ		#obs.	R^2
All treatments, both shifts	14.423	***	-0.002	***	76.007	***	1536	0.99
	(0.684)		(0.000)		(3.319)			
	[13.074, 15.772]		[-0.002, -0.001]		[69.461, 82.554]			
All treatments, shift 1	14.620	***	-0.002	***	77.356	***	768	0.99
	(0.873)		(0.000)		(4.379)			
	[12.897, 16.343]		[-0.003, -0.001]		[68.719, 85.992]			
All treatments, shift 2	13.739	***	-0.002	***	77.292	***	768	0.99
	(0.863)		(0.000)		(3.979)			
	[12.037, 15.441]		[-0.002, -0.001]		[69.444, 85.139]			
Base, shift 1	18.413	***	-0.004	***	60.525	***	768	0.99
	(1.076)		(0.000)		(5.506)			
	[16.290, 20.536]		[-0.005, -0.003]		[49.664, 71.386]			
Base, shift 2	16.033	***	-0.003	***	70.534	***	768	0.99
	(1.082)		(0.000)		(5.183)			
	[13.899, 18.167]		[-0.003, -0.002]		[60.311, 80.756]			
Save, shift 1	16.838	***	-0.003	***	69.363	***	768	0.99
	(0.881)		(0.000)		(4.434)			
	[15.101, 18.576]		[-0.004, -0.002]		[60.616, 78.109]			
Save, shift 2	19.077	***	-0.003	***	56.616	***	768	0.99
	(0.886)		(0.000)		(4.085)			
	[17.330, 20.824]		[-0.004, -0.002]		[48.558, 64.673]			
Shift, shift 1	12.441	***	-0.001		85.298	***	768	0.99
	(1.828)		(0.001)		(9.555)			
	[8.834, 16.047]		[-0.002, 0.000]		[66.450, 104.145]			
Shift, shift 2	11.373	***	-0.001	**	83.703	***	768	0.99
	(1.281)		(0.000)		(5.990)			
	[8.846, 13.901]		[-0.002, -0.000]		[71.887, 95.519]			
Save & Shift, shift 1	12.279	***	-0.002	***	87.143	***	768	0.99
	(1.393)		(0.000)		(6.769)			
	[9.532, 15.026]		[-0.003, -0.001]		[73.792, 100.495]			
Save & Shift, shift 2	13.069	***	-0.001	***	79.406	***	768	0.99
	(1.395)		(0.000)		(6.689)			
	[10.318, 15.820]		[-0.002, -0.001]		[66.212, 92.601]			

Notes: Cluster robust (subject level) standard errors are in parentheses, significance levels are * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 95%-confidence intervals in brackets. *Source:* Authors calculations.

Appendix D. Additional Figures

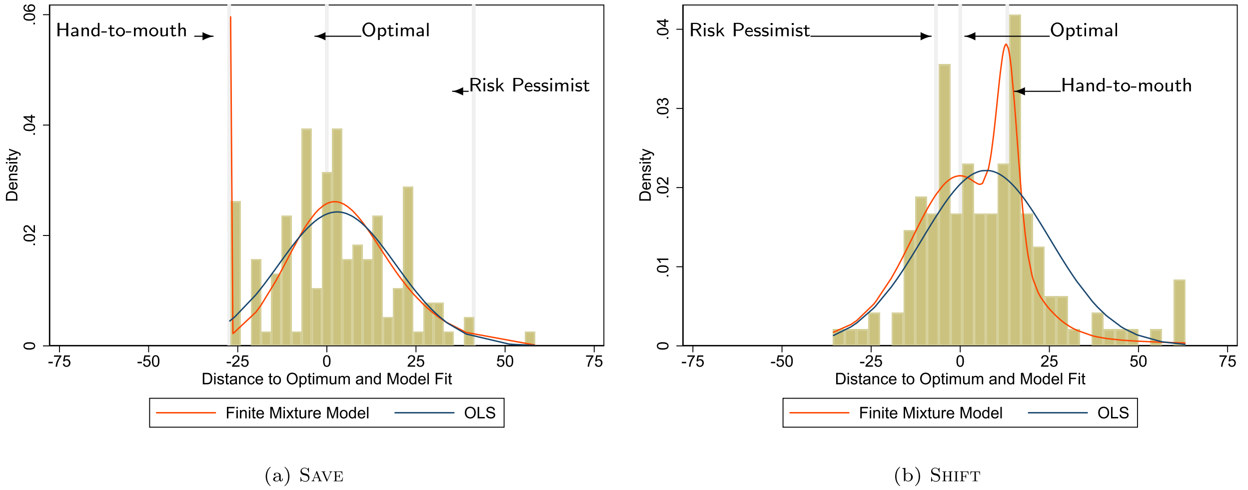


Fig. D.1. Fit of Finite Mixture Models and OLS to Unconditional Optima *Notes:* The histogram of the distance to unconditional optimal share of income saved and optimal share of time spent in shift 1 (in percentage points) is shown in yellow bars, blue lines represent the fit of an OLS model and red lines of finite mixture models. Gray lines show optimal behavior (distance to optimum is 0 percent), risk pessimist behavior (distance to optimum is +13.8 and -6.8 percentage points in Save and Shift, respectively), and hand-to-mouth behavior (distance to optimum is -27.4 and +13.2 percentage points). *Source:* Authors' calculations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

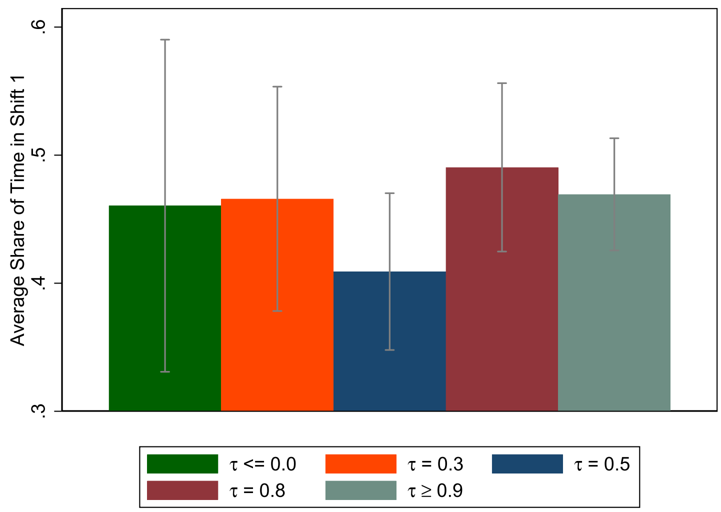


Fig. D.2. Average Share of Time Spent in Shift 1 by τ *Notes:* Sample means and 95%-confidence intervals based on heterogeneous risk preferences as defined in Table 9. Theory predicts that the share of time spent in shift 1 decreases with higher risk aversion and prudence. *Source:* Authors' calculations.

Appendix E. Sample Characteristics

Table E.1 presents summary statistics of our sample. The median person switched to the certain amount of 25 euros instead of the lottery between 65 euros or 5 euros with expected value of 35 in the questions for risk aversion. For both measures of prudence the median person preferred the most prudent option. Subjects classified as other indicated multiple switching points. This means that for all three measures, 85.4, 82.2, and 84.4 percent chose consistently to switch only once. However, they seem not all to follow expected utility theory: while almost 90 percent of subjects behaved according to a coefficient of relative prudence of greater than 2, only about 41 percent chose consistently with a coefficient of relative risk aversion of greater than 1.

Table E.1
Summary of Subjects' Observable Characteristics.

	%	SD		%
Age	23.0	(3.90)	*Field*	
Female	60.9	(48.92)	Psychology	1.56
Semester	5.0	(3.84)	Other	8.85
Risk Aversion			Economics	10.42
Extremely risk averse	42.2		Humanities	10.42
Very, very risk averse	10.9		Sciences	12.5
Very risk averse	15.6		Other social science	17.19
Risk averse	9.4		Law	18.75
Not risk averse	4.7		Business	20.31
Risk loving	2.6		*Subjective Effort*	
Other	14.6		Not demanding at all	6.25
Variance			Not demanding	28.65
Extremely prudent	65.1		Not demanding, not effortless	35.42
Very prudent	7.3		Somewhat demanding	21.35
Prudent	4.7		Quite demanding	6.77
Not prudent	4.2		Very demanding	1.56
Other	18.8		*Attention to Risk*	
Stakes			Inattentive	7.29
Extremely prudent	68.2		Risk pessimist	59.38
Very prudent	7.8		Risk realist	24.48
Prudent	3.6		Risk optimist	8.85
Not prudent	4.7			
Other	15.6			
RRA greater 1	46.9			
RP greater 2	89.6			
RRA greater 1 and RP greater 2	41.1			

Source: Authors' calculations.

Table E.2
Subjective and Incentivised Risk Preferences.

Willingness to take risks	$\tau \leq 0.0$	$\tau = 0.3$	$\tau = 0.5$	$\tau = 0.8$	$\tau = 0.9$	Total	multiple switches
not willing 0	0	0	0	0	1	1	0
1	0	0	0	0	2	2	0
2	0	1	0	1	15	17	0
3	0	3	5	6	24	38	1
4	3	2	4	4	16	29	6
5	0	6	10	6	13	35	8
6	2	1	3	2	5	13	9
7	4	3	5	2	4	18	2
8	4	2	2	0	1	9	2
9	1	0	0	0	0	1	0
very willing 10	0	0	1	0	0	1	0
Total	14	18	30	21	81	164	28

Notes: Cells show self-assessment and incentivized assessment of risk attitudes. Subjects are asked "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" and to self-assess their risk preferences on a 11-point Likert scale. The value 0 means "not at all willing to take risks" and the value 10 means "very willing to take risks". It is intended that this self-assessment is very general and does not refer to any specific circumstances, such as financial affairs or financial lotteries. Subjects were also asked to choose between a save amount of 20, 25, 30, 35, and 40 Euro (right screen) and a lottery (left screen). Each choice was displaied on a separate screen. The lotteries were equiprobable and all randomizations were conducted by the computer. The five choices measuring risk aversion were ordered, such that the certain payoff increased monotonically. 5 subjects switched at 40 and 9 at 35 Euro, aggregated in the first row. τ is determined by the switching point implied by the CRRA payoff function (1). *Source:* Own calculations.

Appendix F. Translation of the Instructions

INSTRUCTIONS

Welcome to this experiment!

In this experiment, you can earn a considerable amount of money. Your earnings in this experiment depend *only* on the choices *you* make during the experiment. Please read the printed instructions and those shown on-screen carefully.

During the experiment, you are not allowed to use electronic devices other than your PC or to talk to other participants. Please only use the computer programs and functions designated for the experiment. Should you have any questions, please raise your hand. We will then quietly answer your question. If the question is of relevance for all participants, we will loudly repeat and answer it.

Outline

Please read the instructions carefully. Afterward, you will answer a few **quiz questions** to make sure you understand everything. Overall, the experiment will take about 1.5 hours.

The experiment is made up of **three parts**. The payoff you are able to receive in each separate part does not depend on your behavior in the other parts.

Part 1

Part 1 is made up of three test periods, which gives you the opportunity to practice the **assignment** you will work on in the second part (the assignment will be explained further down in Part 2). One of the three test periods is randomly chosen for payoff. Only at the end of the experiment, you will be informed about which period was chosen. Further information will show up on your screen.

Part 2

The second part is made up of **four different rounds**, which consist of **two shifts** each. *The time during which you are working on your assignment without an interruption is referred to as a* ***shift***. Only one of the four rounds is relevant for your payoff. Which of the four round earnings will be paid out will be chosen at random. Only at the very end of the experiment, you will be informed about the round that was chosen for payoff.

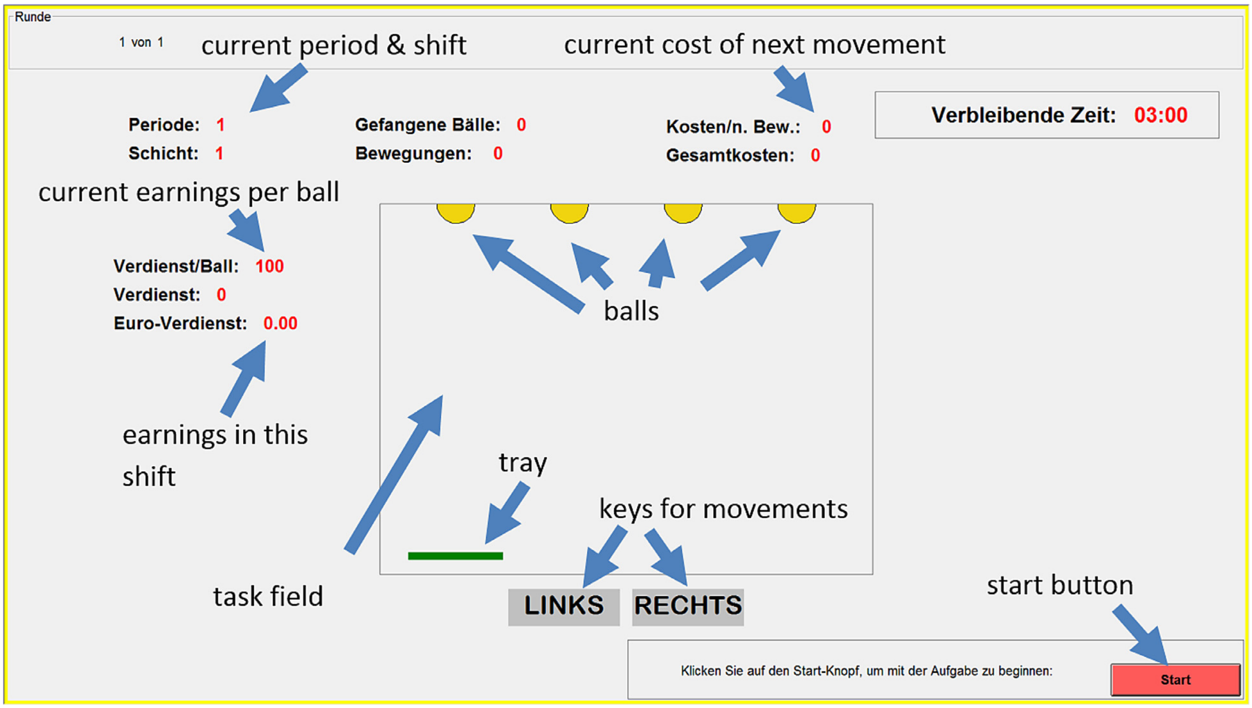
By working on the assignment you can earn **points**. Points are the currency of this experiment. The points you earn during one shift will be converted into euros.

Round 1

In the first round, you are working on the assignment consisting of two shifts. In this round, each shift consists of a period, which always lasts 180 seconds. *A* ***period****is the time during which a particular earning is paid.*

Your assignment

While working on the assignment you will see a **task field** in the middle of the screen, similar to the following figure.



Left of the task field you can see in which **period** and which **shift** you are currently in. As soon as you click the **start button**, the countdown starts and balls start falling randomly from the upper part of the task field. The remaining time is shown in the upper right corner of the screen. The catching tray can be moved by clicking **“LEFT”** or **“RIGHT”** at the bottom part of the task field, in order to catch the balls. To catch a ball, the **catching tray** has to be positioned right underneath the ball, at the moment the ball touches the tray. As soon as the ball touches the tray, the number of balls caught increases by one. The **number of the balls caught so far** and the **number of the current moves** are shown above the task field.

Each move of the catching tray generates costs. Each ball caught generates earnings. The **cost of the next move** is shown above the task field. Underneath you can find the **current overall costs**. The **current earnings per ball** are shown left of the task field. Underneath you can see your earnings in this shift in points and in euros.

Earnings in points are calculated as followed:

Earnings = Number of balls caught * Earnings per ball caught Sum of the costs of the moves

Earnings per ball caught

In each period you will be informed about the **earnings per ball caught**. Your earnings per ball caught are always 100 points throughout the first period. In the **second period**, your earnings per ball caught are determined **randomly**. The earnings may either be 180 points or 20 points. Both values occur with equal probability of 50 percent. In the second period, the point and euro earnings for both 20 and 180 points can be found on the left and the right side of the task field. Only at the end of the experiment you will learn which earning will be paid in the second period.

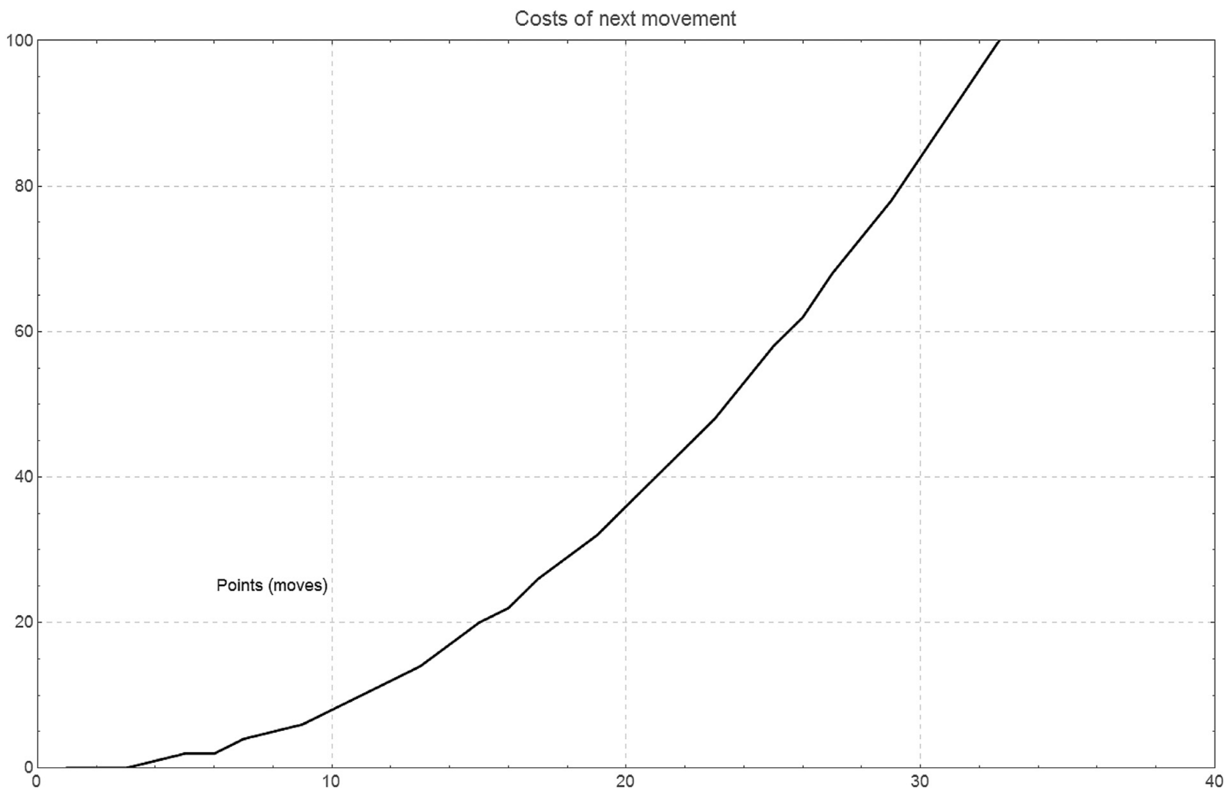
It is important to understand that your earnings per ball caught are randomly generated in the second period. Which value your earnings have in one period, **neither** depends on the value your earnings had in previous periods **nor** on the way you behaved in the previous periods. Only at the very end of the experiment you will be informed about the actual value of your earnings in the second period. That implies that for the duration of the task, you do not know which earnings are relevant for payoff, 20 or 180 points.

Costs for moves

At the start of each shift the **cost for a move** is always zero points. The cost per move increases in the number of moves:

Cost per move = 0.1 * (number of moves so far)^2

The cost per move is rounded to the closest integer. A table with chosen function values is included in the instructions.



Example: Supposing the number of your current moves is 30. The costs per move are calculated as 30*30*0.1 = 90. The next click on æLEFTg or æRIGHTg consequently costs 90 points. After the next click, the number of your current moves increases by one. The costs per move are calculated as 31*31*0.1 = 96.1. The result is rounded to the next integer, 96.

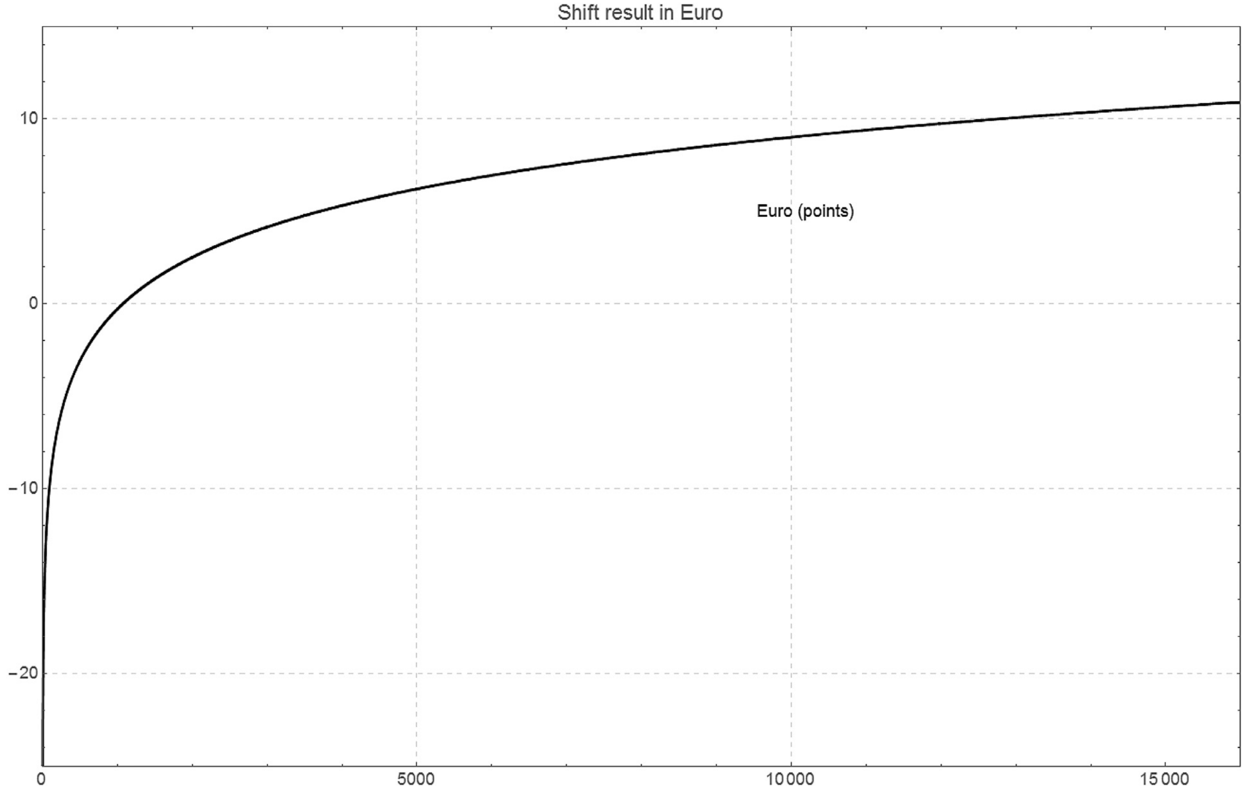
Shift result

The sum of all the points you earned in one shift is your **shift result**. The higher your shift result, meaning the sum of all points earned in one shift, the higher is the payoff in this particular shift. The shift result is converted to euros as followed:

Shift result in euros = 4*[ln(shift result in points) 7].

The following illustration shows the shift result in euros, depending on the points earned. A table with chosen function values is included in the instructions.

Example: Suppose the number of points you earned in the first shift of a round is 6400. Your result for this shift equals 4*[ln(6400) 7) = 7.21 euros. In case you earn 100,000 points in the second shift, your result for this shift is 4*[ln(100,000) 7] = 18.32 euros.



Rounds 2 to 4

The following sections inform you how rounds 2 to 4 differ from round 1.

Round 2

In round 2 you work on the task the same way you did in round 1, for two shifts (which correspond to the periods that last 180 seconds each). Now you have the opportunity to **save** points after the first shift. You can transfer points from the first shift to the second shift. Points that you save are subtracted from the first shift result (accordingly, you earn a lower euro amount in the first shift). The saved points are added to your second shift result (thus, resulting in a higher shift result in euros).

You can save at most so many points that your euro earnings in the first shift are zero. You cannot save a negative amount of points.

Round 3

In round 3 you can decide **how much time** you want to spend in each shift. Overall, you have **360 seconds** at your disposal. The earnings per ball caught in the first period (the first 180 seconds) remain 100 points and the earnings in the second period (the following 180 seconds) remain either 20 or 180 points.

With a button under the task field, you can decide when to end the first shift. After that, the second shift begins.

Example 1: Suppose you end the first shift after 120 seconds. Your shift result for the first shift will be calculated based on the earnings and costs for these 120 seconds. (During these 120 seconds, your earnings per ball caught equal 100 points since you are in the first period.) In the following shift 2, you work on the task for 240 seconds (360 minus 120 seconds). In the first 60 seconds of the second shift, you are still in period 1, meaning you earn 100 points per ball caught. In the following 180 seconds, you are in period 2 and earn either 20 or 180 points per ball caught. Your shift result in points in shift 2 is the sum of the earnings of both periods minus the cost for moves.

Example 2: Suppose you end the first shift after 240 seconds. During the first shift, you are in period 1 during the first 180 seconds and earn 100 points per ball caught. In the following 60 seconds, you are in period 2 and earn either 20 or 180 points (of which the costs are then subtracted). Throughout the second shift (which only lasts 120 seconds) you are in period 2 and earn either 20 or 180 points per ball caught.

Round 4

In round 4 you can save points after the first shift (just as in round 2) as well as decide on the time you want to spend in each shift (just as in round 3).

Part 3

The third part is with regards to content completely unrelated to the first two parts. The instructions for the third part will be shown only on your screen.

Overall pay-out in euros

The result for a round equals the sum of both shift results.

Round result = shift 1 result in euros + shift 2 result in euros.

The overall payoff is calculated as followed:

Overall payoff = result of a random period of part 1

+ result of a random round of part 2

+ amount earned in part 3

The payoff of the random round is rounded to cents. This amount can drop under zero euros, meaning your payoff might be **negative**. In this case, the loss will be settled with the earnings of the other parts. You will not leave this experiment with a loss: Should the overall payoff be negative, you do not get a pay-out.

Questions

Now please answer the quiz questions about the contents of these instructions. Please raise your arm once you are done. In case you have any questions, please also raise your arm. A person in charge will come to you and answer the question.

Appendix G. Tables with Selected Values of the Consumption and Cost Function (Part of the Printed Instructions)

Table G.1
Cost Function.

Costs	
Number of movements so far	Cost of next movement in points
0	0
2	0
4	2
6	4
8	6
10	10
12	14
14	20
16	26
18	32
20	40
22	48
24	58
26	68
28	78
30	90
32	102
34	116
36	130
38	144
40	160
42	176
44	194
46	212
48	230
50	250
52	270
54	292
56	314
58	336
60	360

Table G.2
Consumption Function.

Shift earnings	
Earned points	Value in euros
0	-25.00
1000	-0.37
2000	2.40
3000	4.03
4000	5.18
5000	6.07
6000	6.80
7000	7.41
8000	7.95
9000	8.42
10,000	8.84
11,000	9.22
12,000	9.57
13,000	9.89
14,000	10.19
15,000	10.46
16,000	10.72

H. Translation of the Quiz Questions (With Correct Answers)

Quiz questions

Please answer the following questions before the experiment starts. With these questions we merely intent to make sure that you understand the instructions properly.

1. True or false? Your earnings in period 1 are always 100 points.
   ☒True ☐False
2. What is the probability that your earnings per ball caught in period 2 are 180 points?
   50%
3. True or false? In rounds 3 and 4 you can influence the total duration for which you earn 100 points per ball caught.
   ☐True ☒False
4. True or false? Each time a new shift begins the costs per movement are reset to zero.
   ☒True ☐False
5. In each shift increase the costs per movement in the number of movements so far. But this increase becomes flatter in the number of movements so far.
   ☐True ☒False
6. Suppose you earned 10,000 points in the first shift and 1,000 points in the second shift. What are your euro earnings in each shift and in the round?
   10,000 points = 8.84 euros; 1,000 points = -0.37 euros; together 8.47 euros
7. Suppose that you (based on the earnings given under 6.) saved 2,000 points. What are your euro earnings in each shift and in the round?
   8,000 points = 7.95 euros; 3,000 points = 4.03 euros; together 11.98 euros
8. Suppose that you spent 100 seconds in the first shift.
   a) How many seconds will you spend in shift 2?
      260 seconds
   b) For how many seconds will you earn 100 points per ball caught in shift 2?
      80 seconds
   c) For how many seconds will you earn either 20 or 180 points per ball caught in shift 2?
      180 seconds
9. True or false? You will not learn your payoff during the entire experiment. Only at the very end you will learn this.
   ☒True ☐False

Appendix I. Original Instructions in German

Terminal Nummer:

Instruktionen

Herzlich Willkommen zu diesem Experiment!

In diesem Experiment können Sie einen erheblichen Geldbetrag verdienen. Ihr Verdienst in diesem Experiment hängt *nur* von den Entscheidungen ab, die *Sie* während des Experiments treffen. Bitte lesen Sie diese gedruckten und die auf dem Bildschirm angezeigten Instruktionen aufmerksam durch.

Während des Experiments ist es Ihnen nicht erlaubt, andere elektronische Geräte als Ihren PC zu benutzen oder mit anderen Teilnehmern zu kommunizieren. Bitte benutzen Sie nur die für das Experiment vorgesehenen Programme und Funktionen des Computers. Sollten Sie eine Frage haben, dann heben Sie bitte Ihre Hand. Wir werden Ihre Frage dann im Stillen beantworten. Wenn die Frage relevant für alle Teilnehmer ist, werden wir sie laut wiederholen und beantworten.

Überblick

Als Erstes lesen Sie sich die Instruktionen durch. Anschließend beantworten Sie ein paar **Quizfragen**, damit sichergestellt ist, dass Sie alles verstanden haben. Insgesamt dauert das Experiment etwa 1,5 Stunden.

Das Experiment besteht aus **drei Teilen**. Die Auszahlungen, die Sie in den einzelnen Teilen erzielen können, sind in allen Teilen unabhängig von Ihrem Verhalten in den anderen Teilen.

Teil 1

Der erste Teil besteht aus drei Probeperioden, in denen Sie die **Aufgabe**, die Sie auch im zweiten Teil bearbeiten werden, üben werden (die Aufgabe wird Ihnen weiter unten in Teil 2 erklärt). Eine dieser drei Perioden wird zufällig zur Auszahlung ausgewählt. Erst am Ende des Experiments erfahren Sie, welche Periode ausgewählt wurde. Weitere Informationen werden Ihnen auf dem Bildschirm angezeigt.

Teil 2

Der zweite Teil besteht aus **vier verschiedenen Runden**, welche jeweils aus **zwei Schichten** bestehen. *Als **Schicht** bezeichnen wir den Zeitraum, in dem Sie ohne Unterbrechung an der Aufgabe arbeiten.* Nur eine der vier Runden ist für Sie auszahlungsrelevant. Welches der vier Rundenergebnisse ausgezahlt wird, wird zufällig ausgewählt. Erst ganz am Ende des Experiments wird Ihnen mitgeteilt, welche Runde zur Auszahlung ausgewählt wurde.

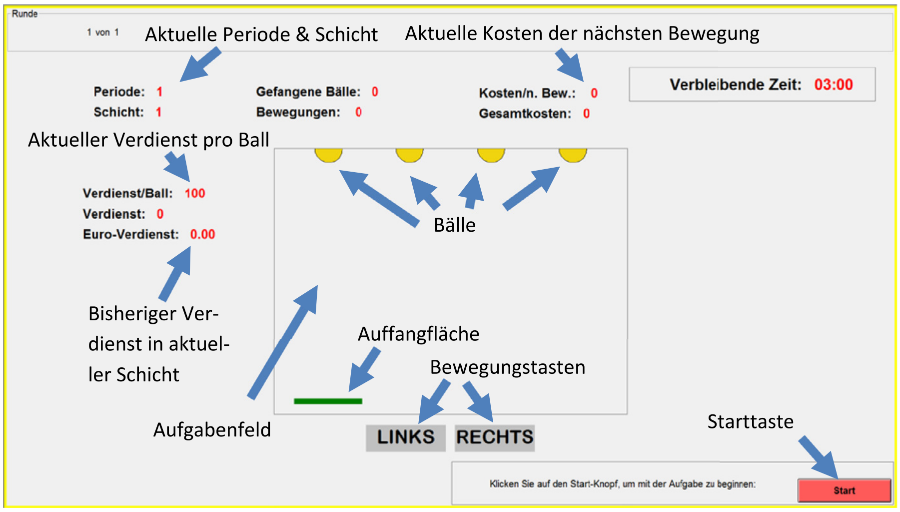
Durch die Bearbeitung der Aufgabe können Sie **Punkte** verdienen. Punkte sind die Währung in diesem Experiment. Die Punkte, die Sie in einer Schicht verdienen, werden dann in Euro umgerechnet.

Runde 1

In der ersten Runde bearbeiten Sie in zwei Schichten die Aufgabe. In dieser ersten Runde besteht jede Schicht aus einer Periode, die immer 180 Sekunden dauert. *Als **Periode** bezeichnen wir den Zeitraum, in dem ein bestimmter Verdienst gezahlt wird.*

Ihre Aufgabe

Während der Bearbeitung der Aufgabe werden Sie ein **Aufgabenfeld** in der Mitte des Aufgabenbildschirms sehen, ähnlich der folgenden Abbildung.



Links vom Aufgabenfeld wird angezeigt, in welcher **Periode** und in welcher **Schicht** Sie sich befinden. Sobald Sie auf die **Starttaste** geklickt haben, beginnt die Zeitmessung und Bälle fallen zufällig vom oberen Rand des Aufgabenfelds herunter. Die Ihnen verbleibende Zeit wird in der oberen, rechten Bildschirmecke angezeigt. Sie können die Auffangfläche am unteren Rand des Aufgabenfeldes durch einen Mausklick auf „**LINKS**" oder „**RECHTS**" schrittweise bewegen, um Bälle zu fangen. Um einen Ball zu fangen, muss sich die **Auffangfläche** unter dem Ball befinden, wenn der Ball die Auffangfläche berührt. Sobald der Ball die Auffangfläche berührt, erhöht sich die Anzahl der gefangenen Bälle um eins. Die **Anzahl der bisher gefangenen Bälle** sowie die **Anzahl der bisherigen Bewegungen** werden über dem Aufgabenfeld angezeigt.

Für jede Bewegung der Auffangfläche entstehen Kosten. Für jeden gefangenen Ball entsteht ein Verdienst. Die **Kosten der nächsten Bewegung** werden über dem Aufgabenfeld angezeigt. Darunter werden die **bisherigen Gesamtkosten** angezeigt. Der **aktuelle Verdienst pro gefangenem Ball** erscheint links vom Aufgabenfeld. Darunter wird angegeben, wie hoch Ihr **bisheriger Verdienst** in dieser Schicht in Punkten und in Euro ist.

Der Verdienst in Punkten ergibt sich aus

$$Verdienst = Zahl\ der\ gefangenen\ Bälle * Verdienst\ pro\ gefangenem\ Ball \\ - Summe\ der\ Kosten\ aller\ Bewegungen.$$

Verdienst pro gefangenem Ball

In jeder Periode werden Sie über den **Verdienst pro gefangenem Ball** informiert. Ihr Verdienst pro gefangenem Ball in der ersten Periode einer Runde beträgt immer 100 Punkte. Ihr Verdienst pro gefangenem Ball in der **zweiten** Periode einer Runde wird **zufällig** ermittelt. Er kann entweder 180 Punkte oder 20 Punkte betragen. Beide Werte treten mit der gleichen Wahrscheinlichkeit von 50% auf. In der

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zweiten Periode werden Ihnen für 20 und 180 Punkte die Verdienste in Punkten und Euro auf der linken und rechten Seite des Aufgabefeldes angezeigt. Sie erfahren erst ganz am Ende des Experiments, welcher Verdienst in der zweiten Periode ausgezahlt wird.

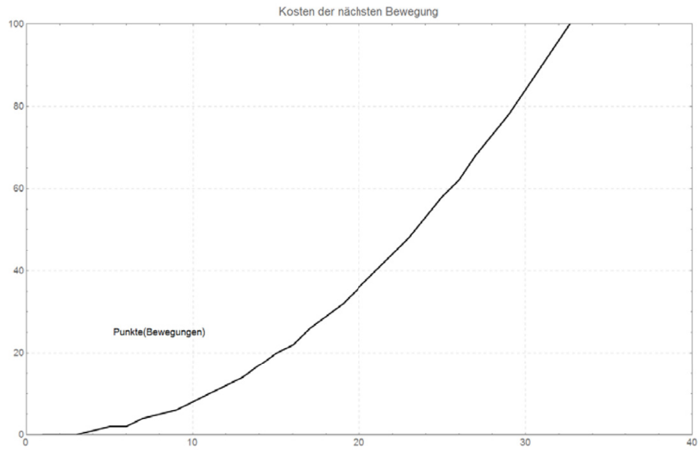
Es ist sehr wichtig zu verstehen, dass Ihr Verdienst pro gefangenem Ball in der zweiten Periode zufällig ermittelt wird. Welchen Wert Ihr Einkommen in einer Periode annimmt, hängt **nicht** davon ab, welche Werte Ihr Verdienst in den Perioden vorheriger Runden angenommen hat oder wie Sie sich in den vorherigen Runden oder Perioden verhalten haben. Erst ganz am Ende des Experiments wird Ihnen mitgeteilt, wie hoch der Verdienst in der zweiten Periode tatsächlich ist. Das bedeutet, dass Sie während der Bearbeitung der Aufgabe nicht wissen, welcher Verdienst auszahlungsrelevant ist, 20 oder 180 Punkte.

Kosten für die Bewegungen

Beim Start jeder Schicht betragen die **Kosten pro Bewegung** immer null Punkte. Die Kosten pro Bewegung steigen dann mit der Zahl der Bewegungen in folgender Form an:

$$Kosten\ pro\ Bewegung = 0{,}1 * (Zahl\ bisheriger\ Bewegungen)^2.$$

Die Kosten pro Bewegung werden auf die nächste ganze Zahl gerundet. Eine Tabelle mit ausgewählten Funktionswerten liegt den Instruktionen bei.



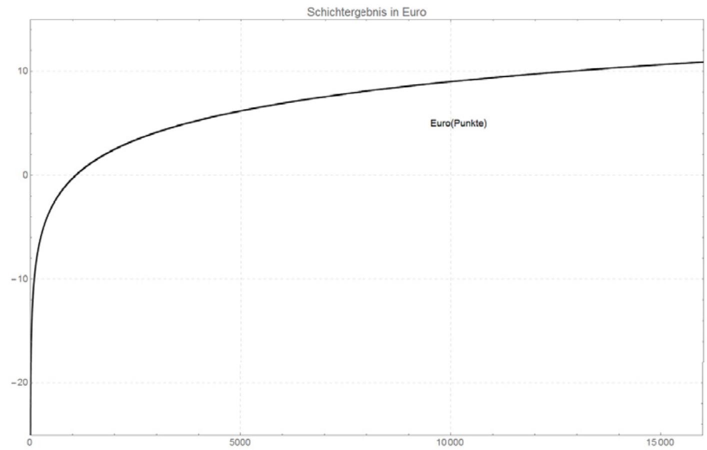
Beispiel: Angenommen, die Zahl Ihrer bisherigen Bewegungen ist 30. Die Kosten pro Bewegung ergeben sich als 30 * 30 * 0,1 = 90. Der nächste Klick auf „LINKS“ oder „RECHTS“ kostet also 90 Punkte. Nach dem nächsten Klick erhöht sich die Anzahl der bisherigen Bewegungen um eins. Es ergeben sich also Kosten pro Bewegung von 31 * 31 * 0,1 = 96,1. Das Ergebnis wird auf die nächste ganze Zahl, also 96 gerundet.

Schichtergebnis

Die Summe aller Punkte, die Sie in einer Schicht erzielt haben, ist Ihr **Schichtergebnis**. Je höher Ihr Schichtergebnis ist, d.h. die Summe aller Punkte innerhalb einer Schicht, desto höher ist der Auszahlungsbetrag dieser Schicht. Das Schichtergebnis wird mit folgender Funktion in Euro umgerechnet:

$$Schichtergebnis\ in\ Euro = 4 * [\ln(Schichtergebnis\ in\ Punkten) - 7].$$

Die folgende Abbildung zeigt das Schichtergebnis in Euro in Abhängigkeit von den erzielten Punkten. Eine Tabelle mit ausgewählten Funktionswerten liegt den Instruktionen bei.



<u>Beispiel:</u> Angenommen, Sie haben in der ersten Schicht einer Runde 6400 Punkte erzielt. Ihr Ergebnis für diese Schicht entspricht $4 * [\ln(6400) - 7]$= 7,21 Euro. Erzielen Sie in der zweiten Schicht 100.000 Punkte, entspricht Ihr Ergebnis für diese Schicht nach Rundung $4 * [\ln(100000) - 7]$ = 18,32 Euro.

Runden 2 bis 4

Die folgenden Abschnitte informieren Sie darüber, wie sich die Runden 2 bis 4 von Runde 1 unterscheiden.

Runde 2

In Runde 2 bearbeiten Sie die Aufgabe wie in Runde 1 für zwei Schichten (die auch gleichzeitig den Perioden zu je 180 Sekunden entsprechen). Jetzt haben Sie die Möglichkeit, nach der ersten Schicht Punkte zu **sparen**. Sie können Punkte aus der ersten Schicht in die zweite Schicht transferieren. Punkte, die Sie sparen, werden von Ihrem ersten Schichtergebnis abgezogen (Sie erzielen also einen Euro-Verdienst in der ersten Schicht, der entsprechend geringer ist). Diese gesparten Punkte werden zu Ihrem zweiten Schichtergebnis hinzuaddiert (so dass Sie in der zweiten Schicht einen entsprechend höheren Euro-Verdienst erzielen werden).

Sie können maximal so viel sparen, dass Ihr Euro-Verdienst in der ersten Schicht null ist. Sie können keinen negativen Betrag sparen.

Runde 3

In Runde 3 können Sie darüber entscheiden, **wie viel Zeit** Sie in den beiden Schichten verbringen möchten. Ihnen stehen **insgesamt 360 Sekunden** zur Verfügung. Wie bislang ist der Verdienst pro gefangenem Ball in der ersten Periode (also in den ersten 180 Sekunden) 100 Punkte und der Verdienst in der zweiten Periode (in den folgenden 180 Sekunden) entweder 20 oder 180 Punkte.

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Über eine Taste unter dem Aufgabenfeld können Sie entscheiden, wann Sie die erste Schicht beenden möchten. Danach beginnt die zweite Schicht.

Beispiel 1: Nehmen Sie an, Sie beenden die erste Schicht nach 120 Sekunden. Dann wird Ihr Schichtergebnis für die erste Schicht anhand Ihres Verdienstes und der Kosten in diesen 120 Sekunden berechnet. (In diesen 120 Sekunden ist jeder gefangene Ball 100 Punkte wert). In der folgenden Schicht 2 bearbeiten Sie die Aufgabe dann 240 Sekunden lang (360 – 120 Sekunden). In der zweiten Schicht verdienen Sie in den ersten 60 Sekunden 100 Punkte je gefangenem Ball und in den folgenden 180 Sekunden entweder 180 oder 20 Punkte je gefangenem Ball. Ihr Schichtergebnis in Schicht 2 besteht dann aus diesen beiden aufaddierten Verdiensten minus der Kosten für die Bewegungen.

Beispiel 2: Nehmen Sie an, Sie beenden die erste Schicht nach 240 Sekunden. In dieser ersten Schicht verdienen Sie dann 100 Punkte je gefangenem Ball in den ersten 180 Sekunden und entweder 20 oder 180 Punkte in den folgenden 60 Sekunden (davon werden dann noch die Kosten abgezogen). In der zweiten Schicht (die dann 120 Sekunden dauert), verdienen Sie dann entweder 20 oder 180 Punkte je gefangenem Ball.

Runde 4

In Runde 4 können Sie sowohl nach der ersten Schicht sparen (wie in Runde 2), als auch bestimmen, wie viel Zeit Sie in den beiden Schichten verbringen möchten (wie in Runde 3).

Teil 3

Der dritte Teil hat inhaltlich nichts mit den anderen beiden Teilen zu tun. Die Anleitung für den dritten Teil wird Ihnen nur auf dem Bildschirm angezeigt.

Gesamtauszahlungsbetrag in Euro

Ihr Rundenergebnis in einer Runde ist die Summe der beiden Schichtergebnisse:

$$Rundenergebnis = Schichtergebnis\ 1\ in\ Euro + \text{Schicht}ergebnis\ 2\ in\ Euro.$$

Der gesamte Auszahlungsbetrag errechnet sich wie folgt:

$$\begin{aligned}&Gesamtauszahlungsbetrag\ in\ Euro\\&\qquad = Ergebnis\ einer\ zuf\text{ä}lligen\ Periode\ aus\ Teil\ 1\\&\qquad + Rundenergebnis\ einer\ zuf\text{ä}lligen\ Runde\ in\ Teil\ 2\\&\qquad + Betrag\ aus\ Teil\ 3.\end{aligned}$$

Der Auszahlungsbetrag aus der zufälligen Runde wird auf Cents gerundet. Dieser Betrag kann unter 0 Euro fallen, ihr Auszahlungsbetrag kann also **negativ** werden. In diesem Fall wird der Verlust mit den Beträgen aus den anderen Teilen verrechnet. Sie werden dieses Experiment allerdings nie mit einem Verlust verlassen: Sollte Ihr Gesamtauszahlungsbetrag dieses Experiments negativ sein, bekommen Sie keine Auszahlung.

Fragen

Als nächstes beantworten Sie bitte einige Quizfragen zu dem Inhalt dieser Instruktionen. Bitte heben Sie Ihren Arm, wenn Sie die Fragen beantwortet haben. Auch falls Sie Fragen haben, melden Sie sich bitte. Ein Experiment-Leiter wird zu Ihnen kommen und Ihre Fragen individuell beantworten.

Appendix J. Example Screen-Shots of the Computer Interface

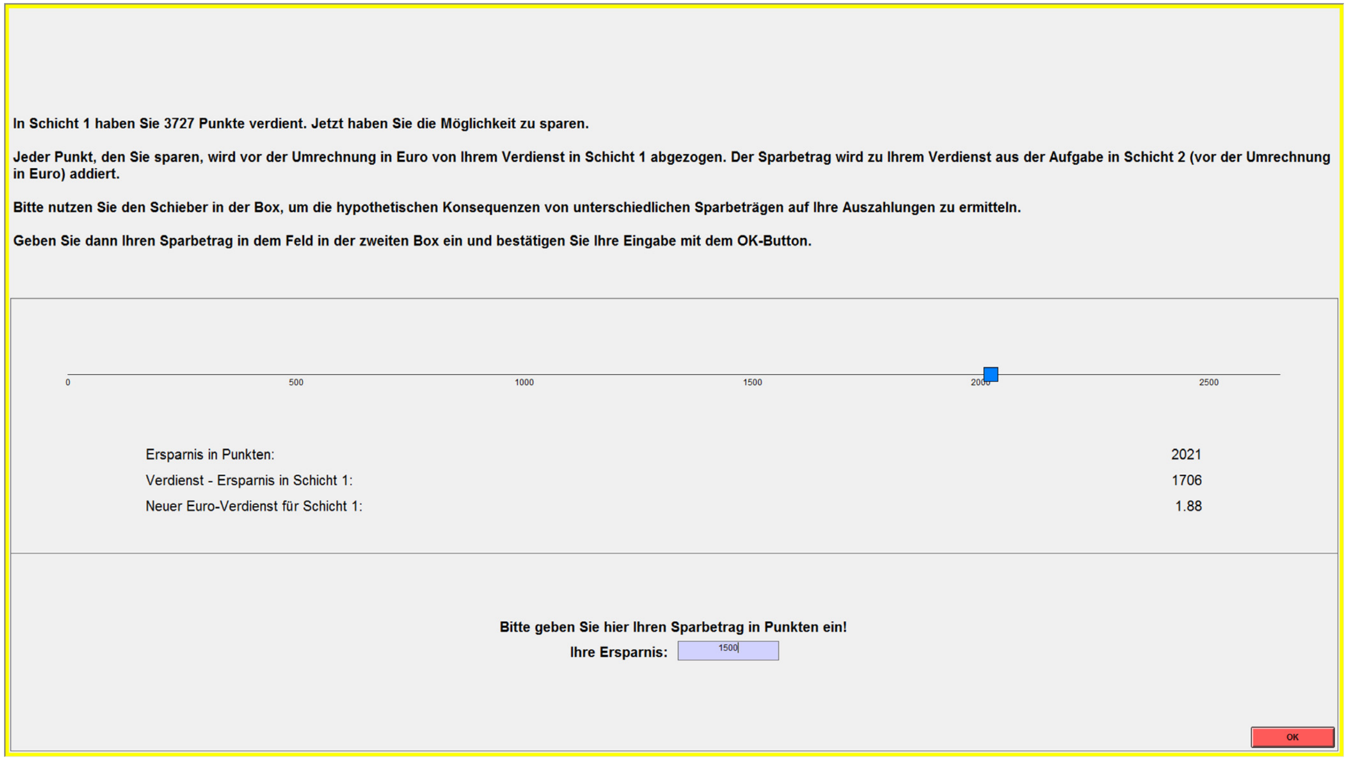

Fig. J.1. Screenshot of Saving Screen. *Source:* Own interface based on z-Tree.

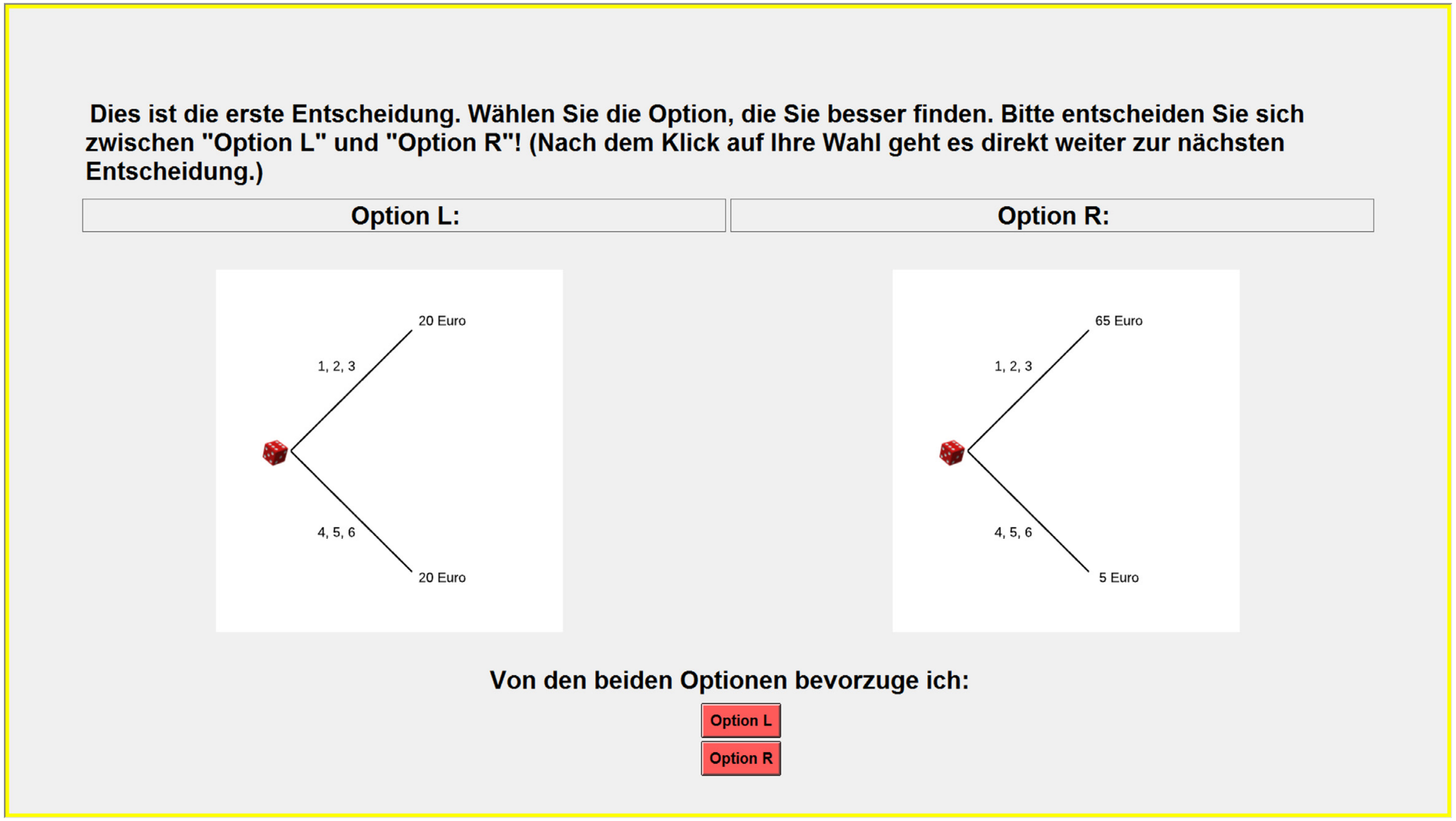

Fig. J.2. Screenshot of the Experimental Interface with the Elicitation of the Risk Aversion and Prudence. *Source:* Own interface based on z-Tree.

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