

ONLINE APPENDIX FOR

“Referral Hiring and Wage Formation in a Market with Adverse Selection”

A. Walrasian Equilibrium of the Experimental Markets

It is instructive to compare the predictions of our model to a situation in which an auctioneer sets wages to equalize supply and demand. Given the experimental parameters, for all wages below 30 the auctioneer would increase the wage: 4 firms would like to hire but only 3 L-type workers are willing to accept the job (excess demand). For wages above 30, H-type workers also enter the market and there is excess supply. This exerts downward pressure on the market wages. The unique Walrasian wage is 30 and at equilibrium 3 L-type workers and 1 H-type worker are hired. The other 2 H-type workers do not enter the market, which is possible because they are indifferent between a wage of 30 and their reservation value. The Walrasian outcome does not depend on the level of risk aversion, because at a wage of 30 firm profits are positive even if hiring an L-type worker, i.e., the profit is $20+20-30=10$. Nonetheless, the hiring patterns observed in the Walrasian equilibrium are inefficient and employee referrals may have an important role in increasing efficiency.

We can also consider a model in which market clearing starts at the highest wage. Then, all wage offers would be equal to 30, as in the Walrasian outcome. It is useful to think of the two models (wage clearing from below and above) as representing two different equilibria: either firms compete aggressively, starting with high wage offers (if markets clear from high to low wages) or firms begin reluctantly by making low offers, waiting for the market to unfold (if markets clear from low to high wages). While both models are tenable, the experimental data shows that offers usually start at the lower end, providing support for the assumptions that wages clear from below. It is also important to note that both models lead to suboptimal hiring patterns, and job referrals are predicted to improve the assignment of workers to firm.

B. Theoretical Exploration of Risk Heterogeneity

Figures B.1 and B.2. below reproduce “Figure 2: Equilibrium Outcomes” of the main article for different constellations of risk preferences.

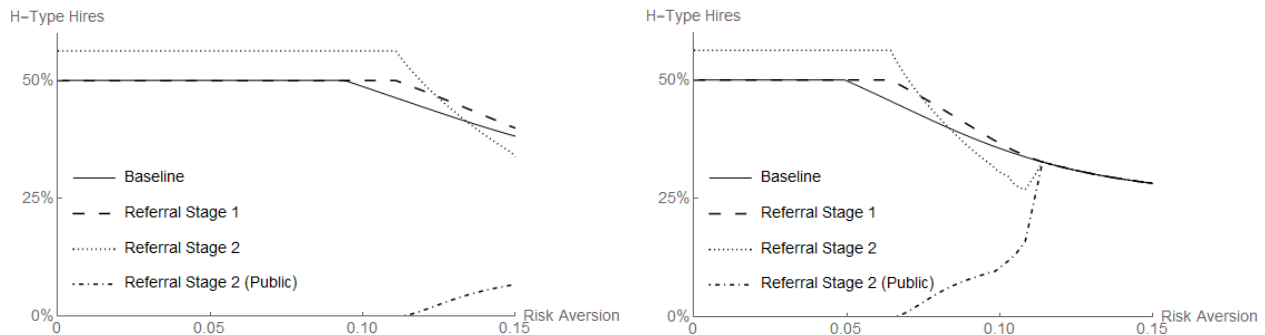
Figure B.1 holds constant *workers’* risk preferences at risk neutrality (left figure) and a CARA parameter of 0.1 (right figure) – the x-axis then varies *firms’* absolute risk aversion. In the Baseline treatment (solid line), the percentage of H-type hired is 50% for low firm risk aversion and decreases once a risk aversion threshold is reached. This threshold is reached earlier if workers are risk averse than if workers are risk

neutral. As described in the paper, this confirms that firms are more likely to offer low wages when workers are risk averse, because the latter prefer accepting a lower wage to trying to obtain a wage greater than 30.

In stage 1 of the Referral treatment, firms are more likely to hire a H-type than in the Baseline treatment due to the possibility of getting access to the network of an H-type worker. As in the Baseline, this effect becomes particularly important for lower firm risk aversion if workers are themselves risk averse than if workers are risk neutral. In stage 2 of the Referral treatment, firms are more likely to hire a H-type worker than in the Baseline treatment due to the use of referral offers. This effect disappears for high firm risk aversion, as offering a high wage through a referral offer becomes too risky compared to offering low initial wages on the public market. Again, the level of firm risk aversion at which the effect of referrals disappears is lower when workers are risk averse than when workers are risk neutral, as worker risk aversion allows firms to offer lower acceptable wages on the public market.

Notice also that the Referral treatment can lead to fewer H-type hires than the Baseline treatment. The reason is that the possibility of H-type referral hires reduces the quality in the public market, which negatively affects firms' willingness to offer high wages. This effect can dominate the increase in H-type hires through referral offers.

Figure B.1: Percentage of H-Type Hires Holding Constant Workers' Risk Preferences

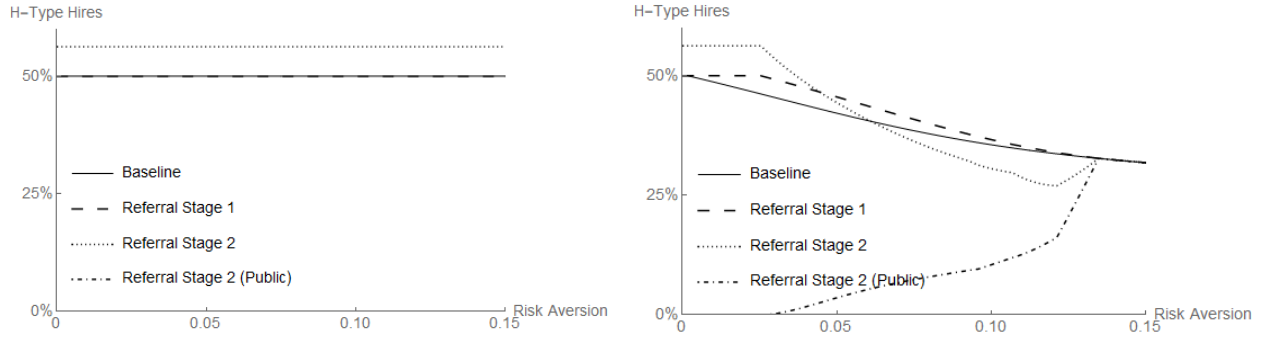


Note: The figures show the effect of increased firm risk aversion (x -axis is the CARA parameter) for fixed worker risk preferences, in particular, for risk-neutrality (left figure) and a CARA parameter of 0.1 (right figure).

Figure B.2 holds constant *firms'* risk preferences at risk neutrality (left figure) and a CARA parameter of 0.1 (right figure) – and the x -axis then varies *workers'* absolute risk aversion. If firms are risk neutral, competition between firms for H-type workers is stronger than with risk averse firms, as risk neutral firms are less concerned about the risk of hiring a L-type worker at a high wage. As can be seen in Figure B.2 (left figure), for the experimental parameters, the percentage of H-type hires is 50% in Baseline, as wage offers are at the high productivity workers' reservation wage of 30. Despite this, the efficiency-enhancing

effect of social links and referral hiring persists in stage 2 of the Referral treatment: the firms which hire a H-type worker in stage 1 use the social link of their stage-1 worker to increase their chances of hiring another H-type worker in stage 2. Thus, employee referrals are valuable also for risk neutral firm. The figure on the right shows that with risk averse firms, increasing worker risk aversion has a very similar effect as the one we observed in Figure B.1 when increasing firm risk aversion.

Figure B.2: Percentage of H-Type Hires Holding Constant Firms' Risk Preferences



Note: The figures show the effect of increased worker risk aversion (x-axis is the CARA parameter) for fixed firm risk preferences, in particular, for risk-neutrality (left figure) and a CARA parameter of 0.1 (right figure). In the left figure, the percentage of H-type hires is 0% in 'Referral Stage 2 (Public)' for all values of workers risk aversion.

To sum up, (i) risk aversion on either market side makes the use of referral hiring more attractive, because firms want to avoid risk or hiring L-types becomes less expensive (risk averse workers accept low wages due to the risk of not being hired), and (ii) too much risk aversion on *either* market side makes referral hiring less beneficial, because the correlation in productivity between two linked workers is not sufficiently strong to justify a high offer (firm risk aversion) or because hiring an L-type in the public market is preferable due to a high willingness of L-type workers to accept low wages (worker risk aversion).

C. Additional Data Analysis

This appendix presents a set of results supporting the main results in the article. Section C.1 discusses behavior over time. Section C.2 discusses further points with regard to the individual-level analysis.

C.1 Period Effects

We implemented 15 periods (two-stage markets) in our experiment to allow for convergence of behavior, which we estimated would require about 5 periods, while still having 10 periods of observed behavior to analyze. In line with this, the analysis in the article is based on periods 6-15. In this appendix, we show the percentage of H-type hires including all 15 periods and provide evidence on convergence of behavior over time.

In the interest of brevity, we focus on what constitutes the clearest message of our paper: the increased percentage of H-type hires in stage 1 and stage 2 in the Referral treatment compared to the Baseline treatment. Table C.1.1 summarizes the average number of L-type and H-type hires, the percentage of H-type hires for both treatments and stages, as well as efficiency over all 15 periods.

Table C.1.1: Summary Statistics Over All Fifteen Periods

Treatment	L-type Hires	H-type Hires	Percentage of H-type	Efficiency
<u>Stage 1</u>				
<i>Baseline</i>	2.7	0.9	25%	54%
<i>Referral</i>	2.5	1.2	33%	62%
<u>Stage 2</u>				
<i>Baseline</i>	2.8	0.9	25%	55%
<i>Referral</i>	2.5	1.2	32%	61%

As can be seen, the number and percentage of H-type hires is larger in treatment *Referral* than in *Baseline*, which leads to an increase in efficiency. Mann-Whitney U tests confirm the significance of the differences in the percentage of H-type hires; $p=0.044$ for Stage 1, $p=0.082$ for Stage 2, and $p=0.028$ when combining the two stages.

The numbers are similar to the ones for period 6-15 reported in the article, although the percentage of H-type hires is 2% lower in both stages of treatment *Referral* when looking at all 15 periods. Indeed, we find in Figure C.1.1 that the percentage of H-type hires increases over time in *Referral*, but decreases in *Baseline*. The treatment effect thus becomes more pronounced over time and behavior becomes more stable. Figure C.1.2 shows that the total number of hires is close to the maximum of 4 in both treatments and all periods, implying that H-types hires replace L-type hires over time in treatment *Referral*.

Figure C.1.1: Percentage of H-Type Hires

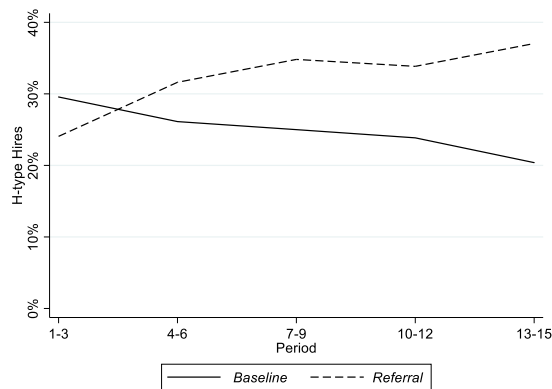
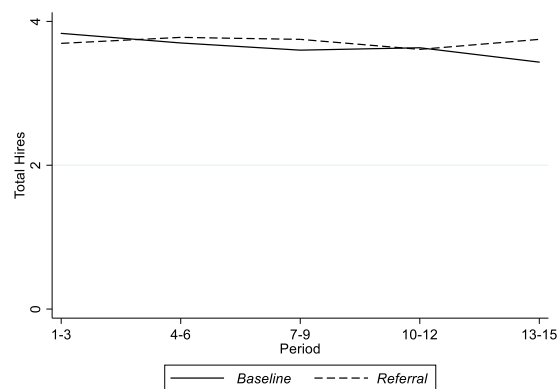


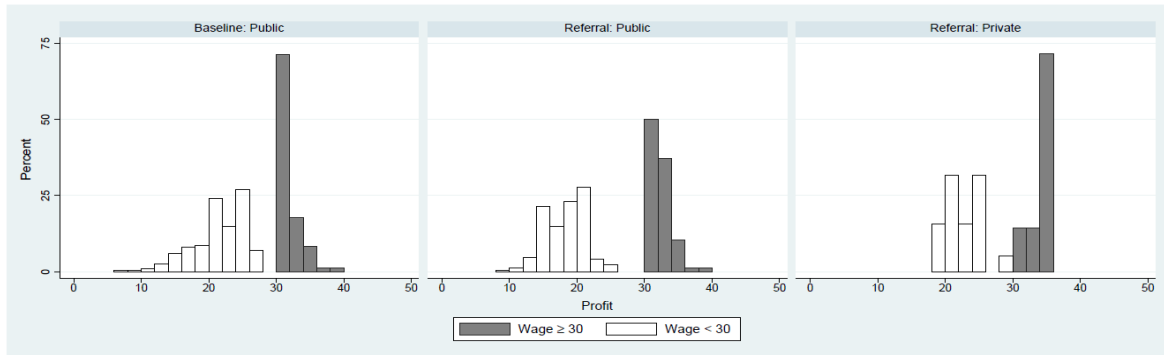
Figure C.1.2: Total Number of Hires



C.2 Additional Individual-Level Analyses

Figure C.2.1 depicts the profits of subjects in the role of an L-type worker separately for wages below and above 30. This is the counterpart for workers to 'Figure 3: Firm Profits' in the main text of the article.

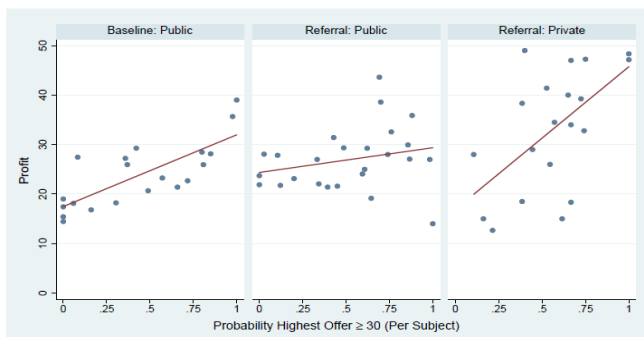
Figure C.2.1: L-Type Profits



Histogram of L-type worker profits separated by whether or not the accepted wage exceeds the H-type workers' reservation wage of 30.

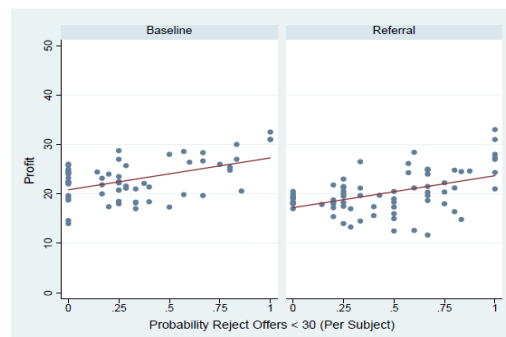
Figure C.2.2 depicts the average profit of an individual in the role of a firm plotted against the fraction of times the individual hired a worker at a wage above 30. Figure C.2.3 provides the corresponding figure for L-type workers. Notice that only few subjects in the role of a firm *always* hired at a wage above or below 30; there is some variation across markets for the same individual. The same applies to L-type workers, although there is group of L-type worker subjects who always accepted low offers, which is either due to risk aversion or because they consider it to be fair behavior. The figures show that the riskier strategies (i.e., offering more than 30 for firms and not accepting offers below 30 for L-type workers) tends to lead to higher expected payoffs.

Figure C.2.2: Firm Profits (by Subject)



Average profit of subjects in the role of a firm plotted against the fraction of hires above a wage of 30.

Figure C.2.3: L-Type Profits (by Subject)



Average profit of subjects in the role of an L-type worker plotted against the fraction of times the subject didn't accept offers below 30.

C.3 Regressions with Bootstrapped Standard Errors

This appendix replicates Tables 2 and 3 in the article using bootstrapped standard errors. Results are quantitatively similar and qualitatively identical to the analyses with session-clustered standard errors.

Table C.3.1: Regression Analysis of Offers and Wages in Stage 1

Dep. Var:	Offer ≥ 30		Wage ≥ 30	
	(1)	(2)	(3)	(4)
Referral	0.12*** (0.03)	0.00 (0.04)	0.15** (0.06)	-0.08 (0.17)
Late (> 60 sec)		0.22*** (0.07)		0.26 (0.21)
Referral \times Late		0.23** (0.10)		0.31 (0.22)
Constant	0.02 (0.03)	0.06* (0.32)	0.33*** (0.07)	0.27* (0.15)
Wald Test ^(a)		$p = 0.004$		$p < 0.001$
Observations	1197	1197	400	400

Notes: Linear random effects models with bootstrapped standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in all regressions. (a) Wald chi-squared tests for the hypothesis ‘Referral + Referral \times Late’ = 0. The reference group in models (1) and (3) is the *Baseline* treatment, whereas in (2) and (4) it is the first 60 seconds of a market stage in *Baseline*.

Table C.3.2: Referral Treatment—Referral Offers and H-type Hires in Stage 2

Dep. Var.	(1)	(2)	(3)	(4)
	Referral Offer (Yes/No)	Offer Level	Offer Level ≥ 30	H-type Hire in Stage 2
Hired H-type in Stage 1	0.353*** (0.0674)	0.235 (1.053)	0.0665 (0.0690)	0.157 (0.139)
Referral Offer (Yes/No)		0.155 (0.388)	-0.0399* (0.0198)	0.0396 (0.188)
Hired H-type in Stage 1 \times Referral Offer (Yes/No)		7.727*** (1.068)	0.266*** (0.053)	0.323 (0.322)
Constant	0.352*** (0.0736)	18.657*** (0.657)	0.179*** (0.0383)	0.225 (0.100)
Observations	735	735	735	204

Notes: Linear random effects models with bootstrapped standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Dependent variables: ‘Referral Offer’ = 1 if ‘yes’, ‘Offer Level’ equals offered wage level, ‘Offer Level ≥ 30 ’ = 1 if yes, ‘H-type Hire in Stage 2’ = 1 if yes. All independent variables are dummy variables equaling 1 if the statement in table is true. Period dummies are included in all regressions. For model (4), a Wald chi-squared test for the hypothesis ‘Hired H-type in Stage 1 + Hired H-type in Stage 1 \times Referral Offer’ = 0 is rejected at $p < 0.001$.

D. Experimental Instructions

General information

Welcome! You will be now taking part in an economic experiment. In the experiment you and other participants will make decisions. How much money you earn depends on your own decisions, the decisions of other participants, and random events. At the end of the experiment the earnings from the experiment will be added up and confidentially paid out to you.

The experiment is divided into 15 periods. In each period you have to make decisions, which you will enter on a computer screen. You will receive specific instructions for the experiment. These instructions will explain how you make decisions and how your decisions, the decisions of other participants and random events influence your earnings. Therefore, it is important that you read these instructions very carefully.

Please switch off your electronic devices. Please do not attempt to **communicate in any other way than specified in the instructions** as otherwise we have to exclude you from the experiment and all earnings you have made will be lost. Please also do not ask questions aloud. If you have a question raise your hand. A member of the experimenter team will come to you and answer your question in private.

[Treatment BASELINE]

EXPERIMENTAL INSTRUCTIONS

Specific instructions for participants in the role of a firm

In this experiment you can earn money with the decisions you make. How much you earn depends on your own decisions, the decisions of other participants and random events. We will not speak of **Euro** during the experiment, but rather of **points**. All your earnings will be calculated in points. At the end of the experiment the total amount of points you earned will be converted to Euro at the following rate:

$$1 \text{ point} = 0.0225 \text{ Euro}$$

First we will explain the basic decision situation. Then, you will learn more specifically how the experiment is conducted. You will also be asked some control questions that will help you understand the decision situation.

Periods

The experiment consists of **15 periods**. Each period consists of **two trading stages** called **stage 1** and **stage 2**. You will make decisions in a labor market where firms make wage offers and workers

can choose which wages to accept. If a worker accepts a wage offer a labor contract is concluded between the corresponding firm and worker.

Roles and Groups

At the beginning of the experiment all participants will be randomly assigned either the **role** of a **firm** or the role of a **worker**. Everyone will **keep** their assigned role throughout the 15 periods.

Workers will be divided into two groups of equal size. Half of the workers will be **active in stage 1** (stage-1 workers). Active means that a worker can accept a wage offer and can be hired. The other half will be **active in stage 2** (stage-2 workers). If a worker is **active** in stage 1, it means that he/she will be inactive in stage 2 (and vice-versa). Inactive means that a worker does not make any decisions and cannot be hired. If you are a worker, whether you are a stage-1 or a stage-2 worker is determined at random at the beginning of each period. That is, a participant in the role of a worker can be a stage-1 worker in some periods and a stage-2 worker in other periods.

Firms are active in both stages, stage 1 and stage 2.

In total there are 16 participants: **4 firms, 6 stage-1 workers, and 6 stage-2 workers**. Note: In each stage there are more workers than firms.

Workers' Types

In each stage (stage 1 and stage 2), there are **two types** of **workers**:

- **Low productivity** workers who produce **20 points if hired**.
- **High productivity** workers who produce **60 points if hired**.

The productivity of a worker is that worker's private information and it is therefore only known to him/her. Workers only know their own productivity and do not know the productivity of other workers. Firms learn a worker's productivity only after the worker has been hired. However, all participants know that in each stage, there are **3 low productivity workers** and **3 high productivity workers**.

The **productivity** of a worker and whether he/she is **active in stage 1** or **stage 2** is **determined at the beginning of each period**. A participant in the role of a worker will be a low productivity worker in some periods and a high productivity worker in other periods, and he/she will be a stage-1 worker in some periods and a stage-2 worker in other periods.

Stages

Recall that each period consists of two trading stages called stage 1 and stage 2. **Each stage lasts at most 2 minutes**. The decisions you will be making depends on your role (firm or worker). In each period the procedures are as follows:

Stage 1: All 4 Firms and the 6 stage-1 workers participate in a **public market** where each firm can make wage offers and each worker can observe the wage offers of all firms. If a stage-1 worker

accepts a wage offer from a given firm, a labor contract is concluded and the firm learns this stage-1 worker's productivity. Both parties then receive their corresponding earnings (explained below).

A firm can employ **at most one worker in stage 1**. Firms can make as many wage offers as they wish. As long as none of the wage offers is accepted, a firm can make new wage offers. A stage 1 worker can accept at most one wage offer. Once a wage offer is accepted the corresponding firm and worker leave the market and are not active anymore in stage 1 of this period (the remaining firms can still hire the remaining workers).

Stage 2: Stage 2 is identical to stage 1, that is, firms can hire workers during 2 minutes by making wage offers and being accepted by one of the workers. The only difference compared with stage 1 is that now the active workers are the **stage-2 workers**.

In stage 1 and in stage 2, submitted wages by a firm have to follow an improvement rule. That is, subsequent wage offers of a firm have to be increasing (in case all standing wage offers have been accepted, a new wage offer can again be below previously accepted wages). Wage offers can be accepted at any time during the trading stage.

The Experimental Procedures in Detail

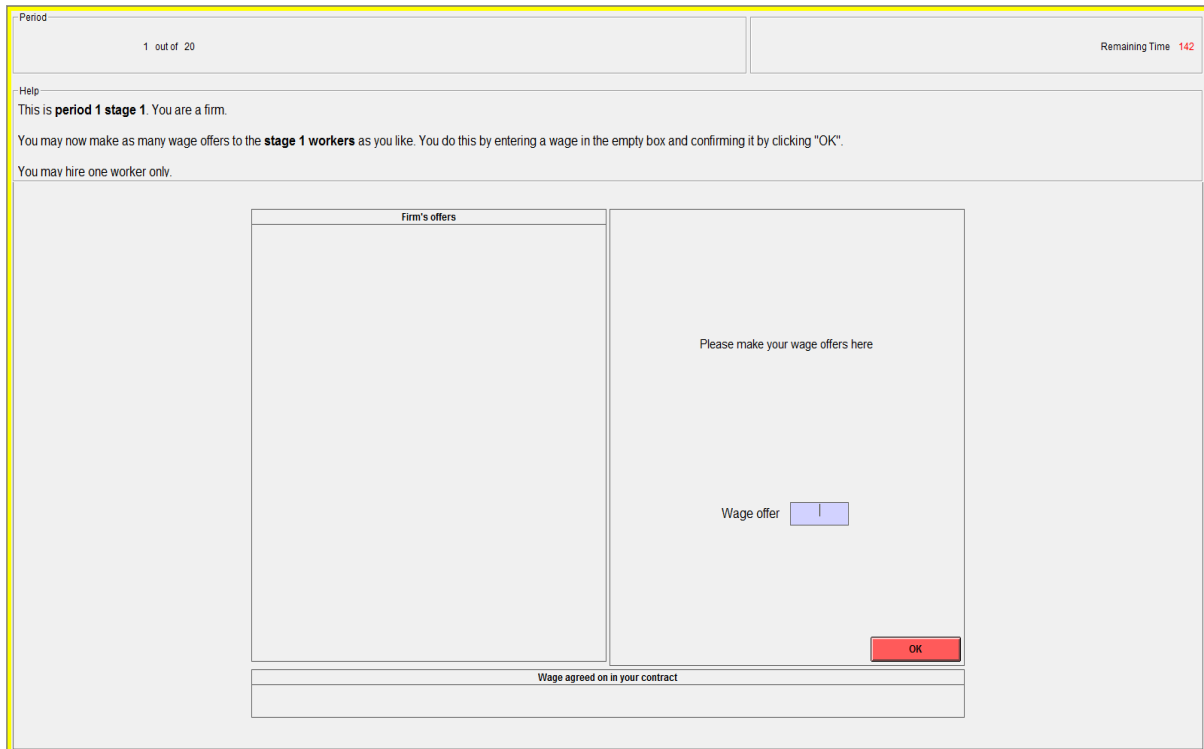
As explained above, there are 4 firms, 6 stage-1 workers and 6 stage-2 workers. In each stage, 3 workers are low productivity workers and 3 are high productivity workers.

If you are a firm you will stay a firm throughout the experiment. If you are a worker you will stay a worker throughout the experiment. However, each worker's productivity and the stage in which he/she is active are randomly assigned in each period.

We now inform you whether you are a firm or a worker. **You have been selected to make decisions in the role of a FIRM.** During the experiment you will enter your decisions via a computer screen. In the following we describe in detail how you make decisions.

➤ Stage 1

Each period starts with stage 1. In stage 1 each firm may hire a stage-1 worker. In order to do so **firms can submit as many wage offers as they wish**. Recall that, in each stage, there are more workers (6) than firms (4). As a firm in stage 1, you will see the following screen:



- In the header “Help”, you see in which period and stage of the experiment you currently are (in this example it’s period 1 and stage 1).
- In the top right corner of the screen you see the time remaining in this trading stage, displayed in seconds.
- Each stage lasts at most 2 minutes (120 seconds). When this time is up the trading stage is over and no further offers can be submitted or accepted in this stage.
- Once the above screen is displayed the trading stage starts. As a firm you can then make wage offers to stage-1 workers in a public market.
 - You can submit a public wage offer by using the right-hand side of the screen. You have to enter a wage in the empty box and then click the “OK” button to submit your offer. After you click “OK” the offer will be displayed to all workers. Offers are seen by all firms and stage-1 workers.
 - Wages have to be an integer number between 0 and 60. **$0 \leq \text{wage offered} \leq 60$** .
 - On the left-hand side of your screen you see the header “Firms’ offer”. All offers made in stage 1 are displayed there. Your offers as well as those of all other firms. **An offer can be accepted by any worker.**
 - **You can make as many wage offers as you like.** Each wage offer that is submitted can be accepted at any time during the trading stage. Wage offers have to follow the improvement rule: each new offer that you make must be higher than the previous one.
 - **A firm can hire at most one worker per stage.** Once a stage-1 worker has accepted your offer it will be notified in the header “Wage agreed on in your

contract". As you can hire at most one workers, your other offers will be automatically canceled and you will not be able to submit further offers.

- Once all firms have hired a worker or when the 2 minutes are over, stage 1 ends.
- No firm is required to submit offers and no worker is required to accept a wage offer.
- When stage 1 is completed each firm learns **the productivity of the worker it has hired**, if any. That is, firms learn whether they hired a worker that produces 20 or 60 points.

➤ **Stage 2**

During stage 2 each firm can hire at most one stage-2 worker. There is **no difference between stage 1 and stage 2 except that now new workers, the stage-2 workers, are active**: firms can submit wage offers to stage-2 workers, everyone can see each other's offers, and stage-2 workers can choose whether or not to accept the wage offers. Stage-1 workers are inactive in this stage.

Determination of your Earnings (as a Firm)

- Each firm is given an "initial budget" of 120 points.
- As a firm you can submit wages between 0 and 60 points. Each wage has to be an integer number, that is, you can offer wages 0, 1, 2, 3, 4, 5, 6, 7, ..., up to 60.
- In each stage a hired worker can be of low or high productivity. A **high productivity worker produces 60 points** and a **low productivity worker produces 20 points**.
- If one of your offers is accepted, your earnings depend on the productivity of the worker and the wage that is accepted by the worker.

If you hire a worker, you earn the productivity of your worker minus the accepted wage plus an extra 20 points. If you don't hire a worker you receive 0 points in that stage.

To summarize:

Firm's earnings if a worker is hired = worker's productivity - accepted wage + 20
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Firm's earnings if no worker is hired = 0
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Your total earnings in a period are equal to the sum of your earnings in stage 1 and 2.

Firm's earnings per period = earnings stage 1 + earnings stage 2

It is possible that you can make losses (negative earnings) in some periods. These losses have to be paid out of your budget of 120 points and the earnings you made in other periods.

After stage 1 is completed you will see an "earnings screen". The screen may look as follows:

Your type:	firm
Productivity of hired worker:	high productivity
Value of production:	60
Wage you have to pay:	60
Your earnings:	20
Your worker's earnings:	60

After stage 2 you will see another earnings screen which may look as follows:

Your type:	firm
Stage 1:	
Productivity of hired worker:	not hired
Value of production:	not hired
Wage to pay:	0
Your worker's earnings:	not hired
Your earnings:	0
Stage 2:	
Productivity of hired worker:	not hired
Value of production:	not hired
Wage to pay:	0
Your worker's earnings:	not hired
Your earnings:	0
Your earnings in this period:	0
Your initial budget is:	120
Your total earnings (inclusive this stage):	120

After the 15 periods are completed you will be asked to fill in a short questionnaire. Thereafter, the experiment is over and you will confidentially be paid out your earnings in the experiment in cash.

It is useful for you to know how the workers' earnings are determined. We explain this below.

Determination of the Workers' Earnings

- Each worker is given an "initial budget" of 120 points.
- A worker can receive wages between 0 and 60 (integer numbers).
- In each period, the earnings of the workers are calculated in the following way:
 - **LOW productivity worker:** If a low productivity worker accepts a wage, he/she earns the wage that he/she has accepted. If he/she does NOT accept a wage, he/she earns the reservation wage of 10 points. In the stage in which the worker is inactive, he/she also earns his/her reservation wage of 10.

Earnings of a low productivity worker in the stage in which he/she is active

= accepted wage if hired

or

= 10 points if not hired

Earnings of a low productivity worker in the stage in which he/she is inactive

= 10 points

Worker's earnings per period = earnings stage 1 + earnings stage 2

- **HIGH productivity worker:** If a high productivity worker accepts a wage, he/she earns the wage that he/she has accepted. If he/she does NOT accept a wage, he/she earns the reservation wage of 30 points. In the stage in which the worker is inactive, he/she also earns his/her reservation wage of 30.

Earnings of a high productivity worker in the stage in which he/she is active

= accepted wage if hired

or

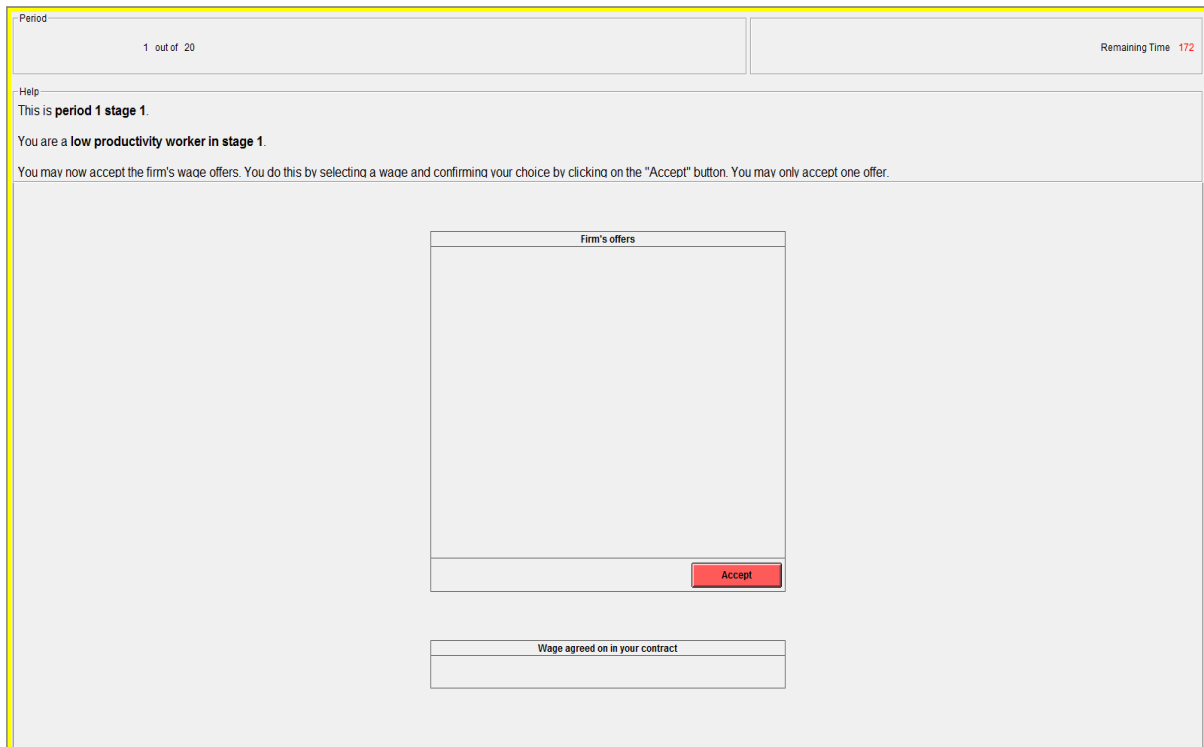
= 30 points if not hired

Earnings of a high productivity worker in the stage in which he/she is inactive

= 30 points

Worker's earnings per period = earnings stage 1 + earnings stage 2

[NOTE: The instructions for workers are identical except that participants are told that they will make decisions in the role of a worker and the workers' computer screen is explained instead of the firms' computer screen. Below we show the workers' decision screen.]



- In the header “Help”, you see in which period and stage of the experiment you currently are (in this example, period 1 and stage 1) as well as your productivity.
- In the top right corner of the screen you see the time remaining in this trading stage, displayed in seconds.
- Each stage lasts at most 2 minutes (120 seconds). When this time is up the trading stage is over and no further offers can be submitted or accepted in this stage.
- Once the above screen is displayed the trading phase starts. As a worker, you can then accept wage offers submitted by the firms. You do this by selecting a wage in the header “Firms’ offers” and then click the "Accept" button. All wage offers appear in this header and can be seen by all firms and workers.
- A worker can accept at most one wage offer. Once you have accepted a wage offer it is notified in the header “Wage agreed on in your contract” at the bottom of the screen and you will not be able to accept further offers.
- Once all firms have hired a worker or after 2 minutes are over, the stage ends.
- No firm is required to submit offers, and no worker is required to accept a wage offer.
- After stage 1 is completed, each firm learns the productivity of the worker it hired.

[Treatment REFERRAL]

EXPERIMENTAL INSTRUCTIONS

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of **Euro** during the experiment, but rather of **points**. All your earnings will be calculated in points. At the end of the experiment the total amount of points you earned will be converted to Euro at the following rate:

$$1 \text{ point} = 0.0225 \text{ Euro}$$

First we will explain the basic decision situation. Then, you will learn more specifically how the experiment is conducted. You will also be asked some control questions that will help you to understand the decision situation.

Periods

The experiment consists of **15 periods**. Each period consists of **two trading stages** called **stage 1** and **stage 2**. You will make decisions in a labor market where firms make wage offers and workers can choose which wages to accept. If a worker accepts a wage offer a labor contract is concluded between the corresponding firm and worker.

Roles and Groups

At the beginning of the experiment all participants will be randomly assigned either the **role** of a **firm** or the role of a **worker**. Everyone will **keep** their assigned role throughout the 15 periods.

Workers will be divided into two groups of equal size. Half of the workers will be **active in stage 1** (stage-1 workers). Active means that a worker can accept a wage offer and can be hired. The other half will be **active in stage 2** (stage-2 workers). If a worker is **active** in stage 1, it means that he/she will be inactive in stage 2 (and vice-versa). Inactive means that a worker does not make any decisions. If you are a worker, whether you are a stage-1 or a stage-2 worker is determined at random at the beginning of each period. That is, a participant in the role of a worker can be a stage-1 worker in some periods and a stage-2 worker in other periods.

Firms are active in both stages, stage 1 and stage 2.

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Workers' Types

In each stage (i.e. both stage 1 and stage 2), there are **two types of workers**:

- **Low productivity** workers who produce **20 points if hired**.
- **High productivity** workers who produce **60 points if hired**.

The productivity of a worker is that worker's private information and it is therefore only known to him/her. Workers only know their own productivity and do not know the productivity of other workers. Firms learn a worker's productivity only after the worker has been hired. However, all participants know that in each stage, there are **3 low productivity workers** and **3 high productivity workers**.

The **productivity** of a worker and whether he/she is **active in stage 1 or stage 2** is **determined at the beginning of each period**. A participant in the role of a worker will be a low productivity worker in some periods and high productivity worker in other periods, and he/she will be a stage-1 worker in some periods and a stage-2 worker in other periods.

Links Between Stage-1 and Stage-2 Workers:

At the beginning of each period, each stage-1 worker is randomly linked to one (and only one) stage-2 worker (called the **referral worker**). Likewise, each stage-2 worker is linked to one stage-1 worker. Importantly, the **probability that a stage-1 worker is linked to a stage-2 worker with the same productivity is 75%**. The **links** between stage-1 and stage-2 workers are **formed** at the **beginning of each period** according to the probability of 75%. As a stage 1 worker, you do not know the productivity of the referral worker.

Recall that workers' types are private information and thus as a firm you do not know a worker's productivity until after you hired him/her. However, **firms learn the productivity of the worker they hired in stage 1 before they make wage offers in stage 2**. For example, if a firm has hired a high productivity stage-1 worker, then the firm knows that there is a chance of 3 out of 4 (or 75%) that this worker is linked to a high productivity stage-2 worker. The chance that the high productivity stage-1 worker is linked with a low productivity stage-2 worker is 1 out of 4 (or 25%).

Stages

Recall that each period consists of two trading stages called stage 1 and stage 2. **Each stage lasts at most 2 minutes**. The decisions you will be making depends on your role (firm or worker). In each period the procedures are as follows:

Stage 1: All 4 Firms and the 6 stage-1 workers participate in a **public market** where each firm can make wage offers and each worker can observe the wage offers of all firms. If a stage-1 worker accepts a wage offer from a given firm, a labor contract is concluded and the firm learns this stage-1 worker's productivity. Both parties then receive their corresponding earnings (explained below).

A firm can employ **at most one worker in stage 1**. Firms can make as many wage offers as they wish. As long as none of the wage offers is accepted, a firm can make new wage offers. A stage 1 worker can accept at most one wage offer. Once a wage offer is accepted the corresponding firm and worker leave the market and are not active anymore in stage 1 of this period (the remaining firms can still hire the remaining workers).

Stage 2: Firms and stage-2 workers participate in a **public and a referral market**. Firms can submit two types of wage offers: public offers and referral offers.

Public offers: Like in stage 1, a public wage offers by firms are observed and can be accepted by all stage-2 workers. The public market is thus identical to the one in stage 1.

Referral offers: In addition to public offers, a firm can make referral offers that are made specifically for the stage-2 worker who is linked with the worker a firm hired in stage 1. **Referral**

wage offers made by a firm are thus received only by the stage-2 worker with a link to the stage-1 worker the firm has hired in stage 1. In other words, a referral wage offer made by a firm can be observed and accepted only by this firm's referral worker. *Note:* If a firm makes a referral offer it does not know the productivity of its referral worker. However, a firm knows (i) the productivity (20 or 60) of the worker it hired in stage 1 and (ii) that there is a 75% probability that the stage-2 worker is of the same productivity as the hired stage-1 worker.

A firm can employ at most one worker in stage 2. Firms are free to make **wage offers in both the public and the referral market simultaneously** (but they don't have to make offers in either market). As long as no worker has accepted a firm's offers, the firm can make new wage offers (public or referral offers). Once a wage offer is accepted the corresponding firm and worker leave the market and are not active anymore in stage 2 of this period.

In stage 1 and in stage 2, submitted wages by a firm have to follow an improvement rule. That is subsequent wage offers of a firm have to be increasing (once all standing wage offers have been accepted, a new wage offer can again be below previously accepted wages). Wage offers can be accepted at any time during the trading phase.

The Experimental Procedures in Detail

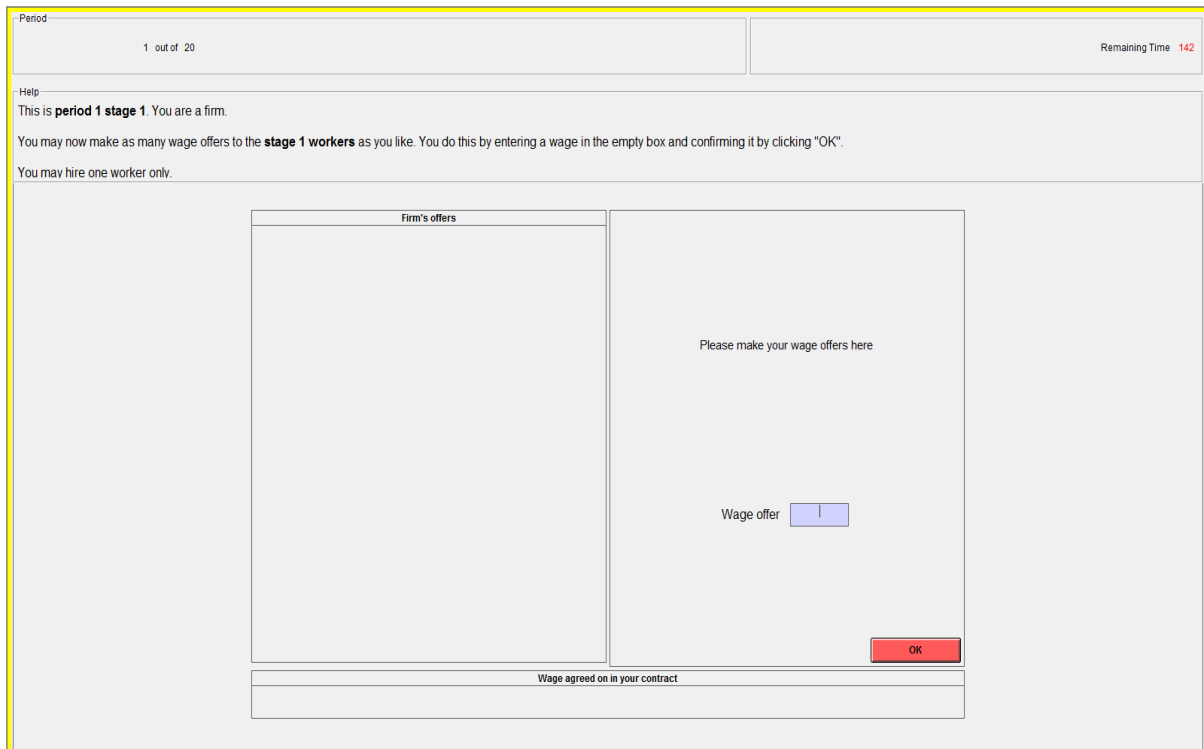
As explained above, there are 4 firms, 6 stage-1 workers and 6 stage-2 workers. In each stage, 3 workers are low productivity workers and 3 are high productivity workers.

If you are a firm you will stay a firm throughout the experiment. If you are a worker you will stay a worker throughout the experiment. However, each worker's productivity and the stage in which he/she is active are randomly assigned in each period.

We now inform you whether you are a firm or a worker. You have been selected to make decisions in the role of a **FIRM**. During the experiment you will enter your decisions via a computer screen. In the following we describe in detail how you make decisions.

➤ Stage 1

Each period starts with stage 1. During stage 1 each firm may hire a stage-1 worker. In order to do so **firms can as many wage offers as they wish**. Recall that in each stage there are more workers (6) than firms (4). As a firm in stage 1, you will see the following screen:



- In the header “Help”, you see in which period and stage of the experiment you currently are (in this example, period 1 and stage 1) as well as some additional useful information.
- In the top right corner of the screen you see the time remaining in this trading stage, displayed in seconds.
- Each stage lasts at most 2 minutes (120 seconds). When this time is up the trading stage is over and no further offers can be submitted or accepted in this stage.
- Once the above screen is displayed the trading stage starts. As a firm you can then make wage offers to stage-1 workers in the public market.
 - You can submit a wage offer by using the right-hand side of the screen. You have to enter a wage in the empty box and then click the “OK” button to submit your offer. After you click “OK” the offer will be displayed to all workers. Public offers are seen by all firms and stage-1 workers.
 - To determine which wage you offer you just have to enter an integer number between 0 and 60. $0 \leq \text{wage offered} \leq 60$.
 - On the left-hand side of your screen you see the header “Firms’ offer”. All offers made in stage 1 are displayed there. Your offers as well as those of all other firms. **An offer can be accepted by any worker.**
 - **You can make as many wage offers as you would like to.** Each wage offer that is submitted can be accepted at any time during the trading stage. Wage offers have to follow the improvement rule: each new offer that you make must be higher than the previous one.
 - **A firm can hire at most one worker per stage.** Once a stage-1 worker has

accepted your offer it will be notified in the header “Wage agreed on in your contract”. As you can hire at most one workers, your other offers will be automatically canceled and you will not be able to submit further offers.

- Once all firms have hired a worker or when the 2 minutes are over, stage 1 ends.
- No firm is required to submit offers and no worker is required to accept a wage offer.
- When stage 1 is completed each firm learns **the productivity of the worker it has hired**, if any. That is, firms learn whether they hired a worker that produces 20 or 60 points.

➤ Stage 2

In stage 2 each firm can hire at most one stage-2 worker. Stage-1 workers are inactive. The difference between stage 1 and stage 2 is that while in stage 1 firms can only make public offers, **firms in stage 2 can make wage offers in a public and a referral market**. As a firm in stage 2, you will make decisions via a screen such as the one below:

- The screen in stage 2 looks similar to the one in stage 1.
- Once the above screen is displayed and stage 2 starts firms can make wage offers to stage-2 workers in **the public market and the referral market**.
 - **Public offers.** The rules are precisely as in stage 1. All public wage offers appear on the left side of the screen. To make a public wage offer you have to click on the button “public market”, enter the wage in the empty box “wage offer” and then click on the “OK” button. Public offers are seen by all firms and stage-2 workers.
 - **Referral offers.** A referral offer is transmitted to one stage-2 worker only. Specifically, it is transmitted **to your referral worker, that is, to the stage-2 worker who is linked with the stage-1 worker you previously hired in stage 1**. Only the referral worker observes your referral wage offers and only he/she can

accept the offer. Note that each firm can have at most one referral worker and no two firms will have the same referral worker. Your referral offers appear in the middle of the screen in the header "your referral wage offers". Your referral worker can also see these offers. Recall: the probability of a stage-1 worker to be linked to a stage-2 worker of the same productivity is 75%.

- **You can only make referral offers if you have hired a stage-1 worker.** If you haven't hired a stage-1 worker you can make offers only in the public market.
- If you want to make a referral offer, select "referral market" and then enter your wage offer in the empty box. Then click on the "OK" button.
- Wage offers (public or referral) have to be an integer number between 0 and 60 and you can make as many offers as you wish. Wage offers (public or referral) can be accepted at any time during a trading stage.
- In each stage a firm can hire at most one worker. Once a stage-2 worker has accepted your offer it will be notified in the header "Wage agreed on in your contract".

Determination of your Earnings (as a Firm)

- Each firm is given an "initial budget" of 120 points.
- As a firm you can submit wages between 0 and 60 points. Each wage has to be an integer number, that is, you can offer wages 0, 1, 2, 3, 4, 5, 6, 7, ..., 60.
- In each stage a hired worker can be of low or high productivity. A **high productivity worker produces 60 points** and a **low productivity worker produces 20 points**.
- If one of your offers is accepted, your earnings depend on the productivity of the worker and the wage that is accepted by the worker.

If you hire a worker, you earn the productivity of your worker minus the accepted wage plus an extra 20 points. If you don't hire any worker, you receive **0 points** in that stage.

To summarize:

Firm's earnings if a worker is hired = worker's productivity - accepted wage + 20
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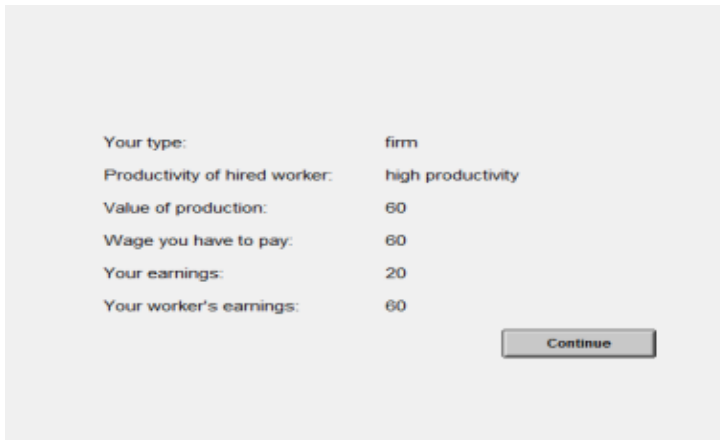
Firm's earnings if no worker is hired = 0
--

Your total earnings in a period are equal to the sum of your earnings in stage 1 and 2.

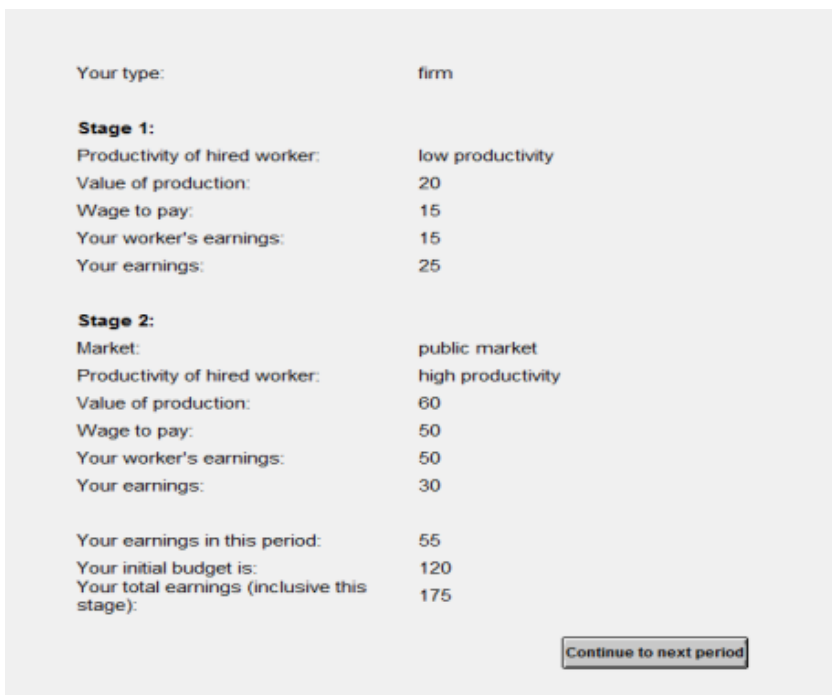
Firm's earnings per period = earnings stage 1 + earnings stage 2

It is possible that as a firm, you can make losses (negative earnings) in a given period. These losses have to be paid out of your budget of 120 points and the earnings you made in other periods.

Once stage 1 is completed you will see an "earnings screen". The screen may look as follows:



Once stage 2 is completed you will see another earnings screen that may look as follows:



After the 15 periods are completed you will be asked to fill in a short questionnaire. Thereafter, the experiment is over and you will confidentially be paid out your total earnings in the experiment in cash.

It is useful for you to know how the workers' earnings are determined. We explain this below.

Determination of the Workers' Earnings

- Each worker is given an “initial budget” of 120 points.
- A worker can receive wages between 0 and 60 (integer numbers).
- In each period, the earnings of the workers are calculated in the following way:

- **LOW productivity worker:** If a low productivity worker accepts a wage, he/she earns the wage that he/she has accepted. If he/she does NOT accept a wage, he/she earns the reservation wage of 10 points. In the stage in which the worker is inactive, he/she also earns his/her reservation wage of 10.

Earnings of a low productivity worker in the stage in which he/she is active

= accepted wage if hired

or

= 10 points if not hired

Earnings of a low productivity worker in the stage in which he/she is inactive

= 10 points

Worker's earnings per period = earnings stage 1 + earnings stage 2

- **HIGH productivity worker:** If a high productivity worker accepts a wage, he/she earns the wage that he/she has accepted. If he/she does NOT accept a wage, he/she earns the reservation wage of 30 points. In the stage in which the worker is inactive, he/she also earns his/her reservation wage of 30.

Earnings of a high productivity worker in the stage in which he/she is active

= accepted wage if hired

or

= 30 points if not hired

Earnings of a high productivity worker in the stage in which he/she is inactive

= 30 points

Worker's earnings per period = earnings stage 1 + earnings stage 2

[NOTE: The instructions for workers are identical except that participants are told that they will make decisions in the role of a worker and the workers' computer screen is explained instead of

the firms' computer screen. Below we show the workers' decision screen. It looks similar to the screen the workers see in the *Baseline* treatment except that now they can accept public *and* referral wage offers.]

Period 1 out of 20 Remaining Time 156

Help
This is **period 1 stage 2**. You are a **high productivity worker in stage 2**.
You may now accept the firm's wage offers. You do this by selecting a wage and confirming your choice by clicking on the corresponding "Accept" button. You may only accept one offer.

Referral wage offers	Firm's public wage offers
Referral wage	Wage offers

Accept referral offer Accept public offer

Wage agreed on in your contract

The screenshot displays a web-based interface for a worker's decision-making process. At the top, it shows the current period (1 out of 20) and the remaining time (156 seconds). Below this, a help section identifies the worker as a high productivity worker in stage 2 of period 1, stage 2, and explains that they can accept one firm's wage offer by selecting a wage and clicking an "Accept" button. The main area is divided into two columns: "Referral wage offers" and "Firm's public wage offers". Each column contains a sub-header and a large empty box for selecting a wage. At the bottom of each column is a red "Accept" button ("Accept referral offer" and "Accept public offer" respectively). Below the columns is a box labeled "Wage agreed on in your contract".