Performance Pay and Multidimensional Sorting: Productivity, Preferences, and Gender

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PART 1: Introduction

- Background
- Approach
- Research Questions

Introduction · Backgroud

- Providing **proper incentive schemes** is important for tackling a contract enforcement problem.
- Considering **worker self-election** is conducive to aligning the interests of principals and agents.
- Worker self-election is likely to depend both on the incentive effect per se and the **sorting effect**.
- Little is known **empirically** about the nature of the selction/sorting process along other dimensions such as workers' preferences and attitudes.

Introduction · Approach

- **field data v.s. experimental data**
- Relevant data in difficult to obtain in the field.
- Experiments offer a valuable tool for studying incentives and sorting in a **controlled** environment.
  - Define material incentives
  - Measure individual productivity,characteristics and preferences
  - Mix implicit or explicit incentives
  - Eliminate influence of timing

Introduction · Research Questions

- Which **personal characteristics** beyond **individual productivity differences** provoke workers to **self-select** into **variable** instead of fixed-pay contracts?
- In particular, how do **relevant characteristics** like risk aversion, relative self-assessment, social preferences, gender, or personality shape the selection process?

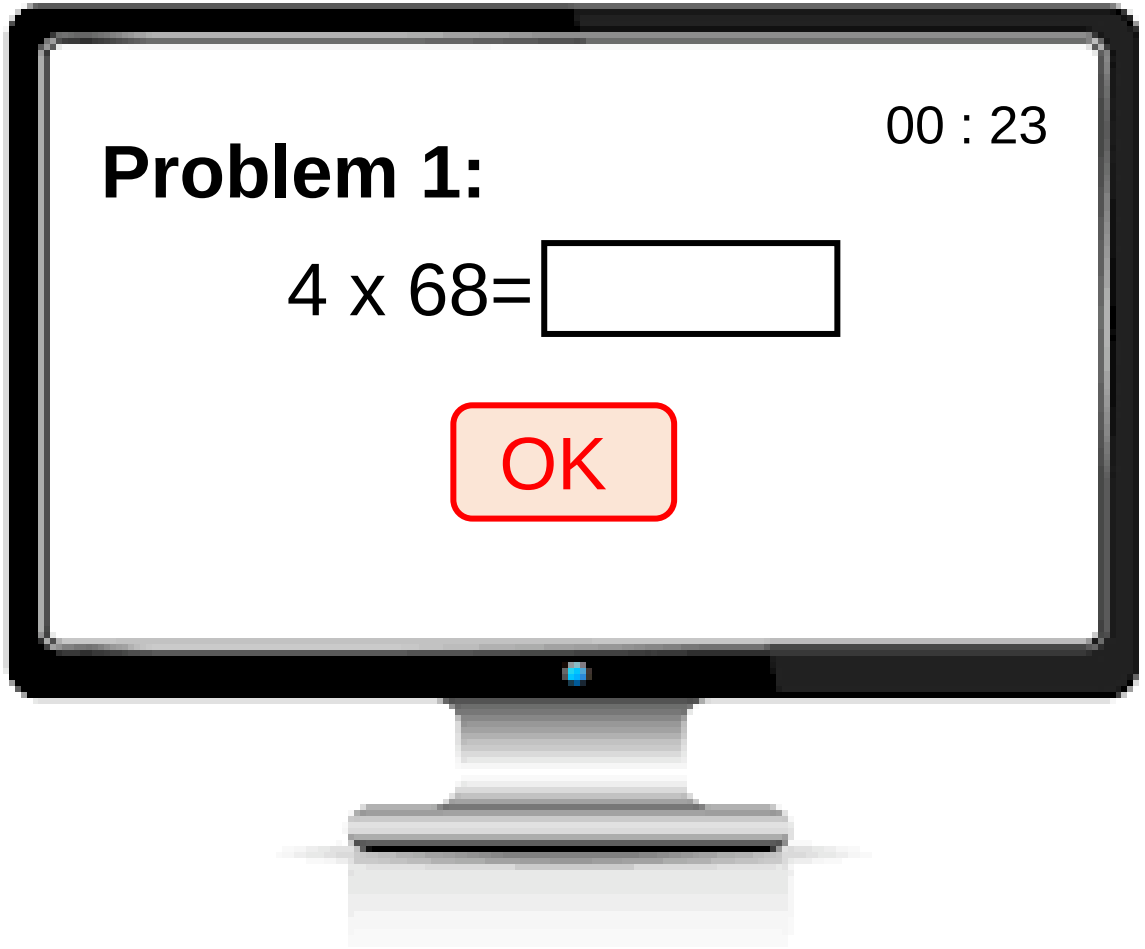
PART 2: Experiment

- Work Task
- Design
- Procedure

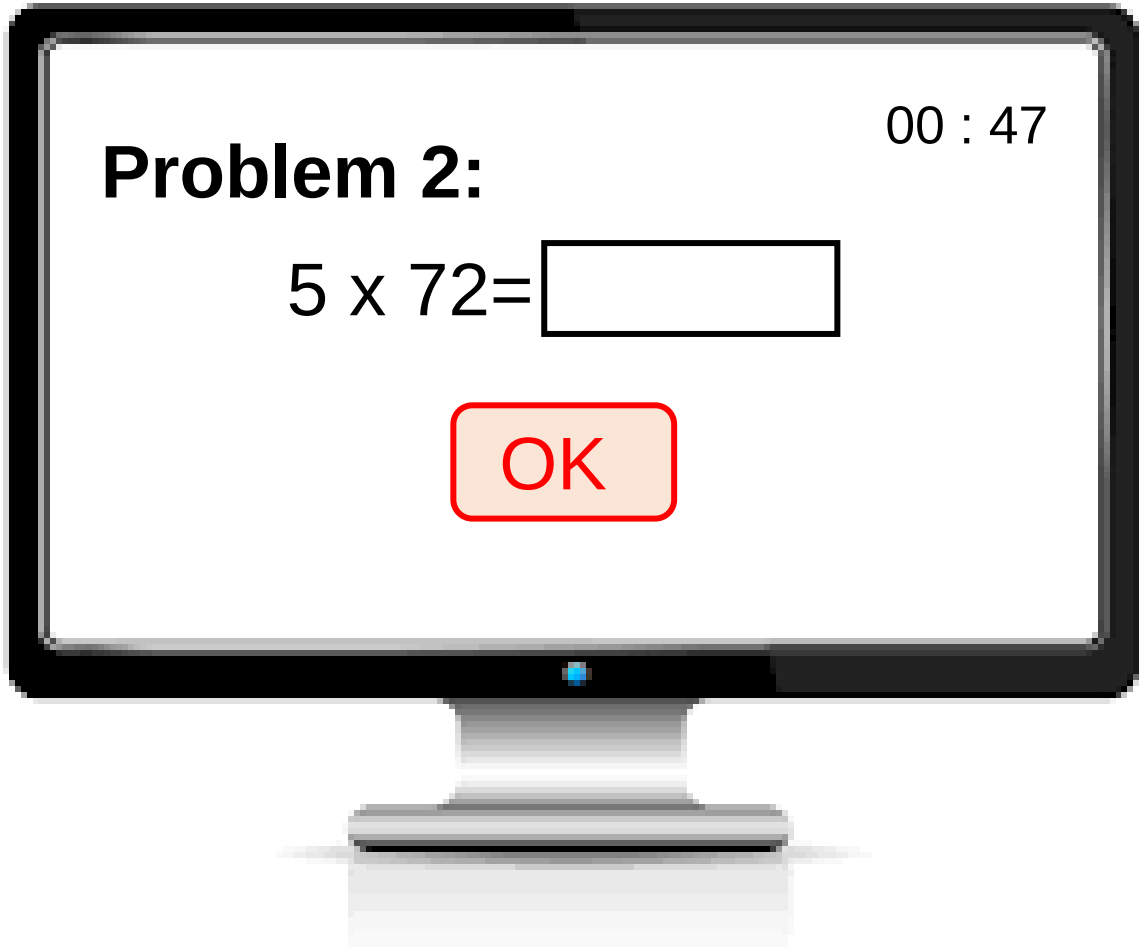
Experiment · Work Task

- Multiply one-digit numbers by two-digit numbers
  - real effort task
  - no previous knowledge required
  - easy to explain
  - enough heterogeneity in productivity
  - proxy for general cognitive ability
- Five different degrees of difficulty
  - level 1: 11 x 9
  - level 2: 3 x 32
  - level 3: 6 x 43
  - level 4: 4 x 68
  - level 5: 7 x 89

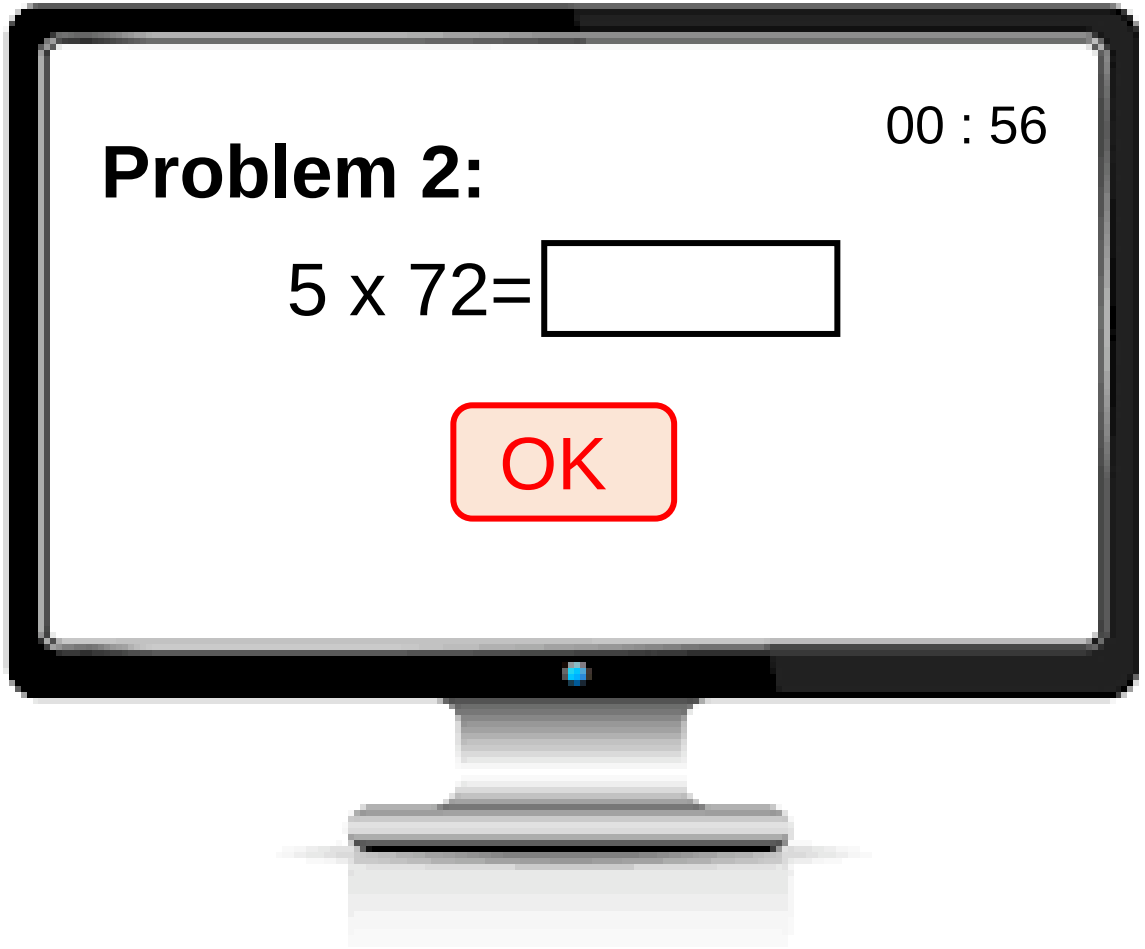
Experiment · Work Task



Experiment · Work Task · If True



Experiment · Work Task · If Flase



Experiment · Design · Beginning

- The same number of females and males were invited to one session.
  - 12 men and 12 women
  - the first **20** subjects participated in the session
  - anonymous
- A written overview were handed out to subjects.
  - the work task
  - a basic structure of the experiment
  - no aids allowed for answering the problems
- Most instuctions were presented on the computer screen.

Experiment · Design · Step 1

- Calculate one multiplication problem as fast as possible.
- The problem had a degree of difficulty 4.
- **No payment was involved**.
- The **time** used is **Productivity Indicator 1.**

Experiment · Design · Step 2

- Calculate one multiplication problem as fast as possible.
- The problem had a degree of difficulty 4.
- **Endowment:150 points**
- **5 points would be substracted per seconds.**
- The **time** used is **Productivity Indicator 2.**

Experiment · Design · Step 3

- Calculate problems in 5 minutes.
- The problems had **different difficulty levels** with random sequence which is same for each subject.
- **10 points per correct answer.**
- The **number** is **Productivity Indicator 3.**

Experiment · Design · Step 4

- Assess performance in step 3 by themselves.
  - *How much effort did you exert?*
  - *How stressed did you feel?*
  - *How exhausted did you get?*
- Answer these questions on a seven-point Likert scale.
  - *1: not at all*

  - *7: very much*

Experiment · Design · Step 5

- Assessed performance in step 3 **relative to others' performance**.
  - *How many of the other 19 participants solved more questions than you did?*
- Have incentives to answer accurately.
  - a correct estimate: 100 points
  - a estimate within 1: 50 points
  - other conditions: 0 points

Experiment · Design · Step 6

- Choose between a variable contract and a fixed-payment contract.
  - the fixed-pay scheme:

$$w_i^F = 400$$

  - the variable-pay sheme – peice rate

$$w_i^{PR} = 10x_i$$

  - the variable-pay sheme – tournament

$$w_i^T = \begin{cases} 1300 \\ 1300 \text{ (p=0.5) or } 0 \text{ (p=0.5)} \\ 0 \end{cases}$$

  - the variable-pay sheme – revenue sharing

$$w_i^{PR} = 10(x_i + x_i)/2$$

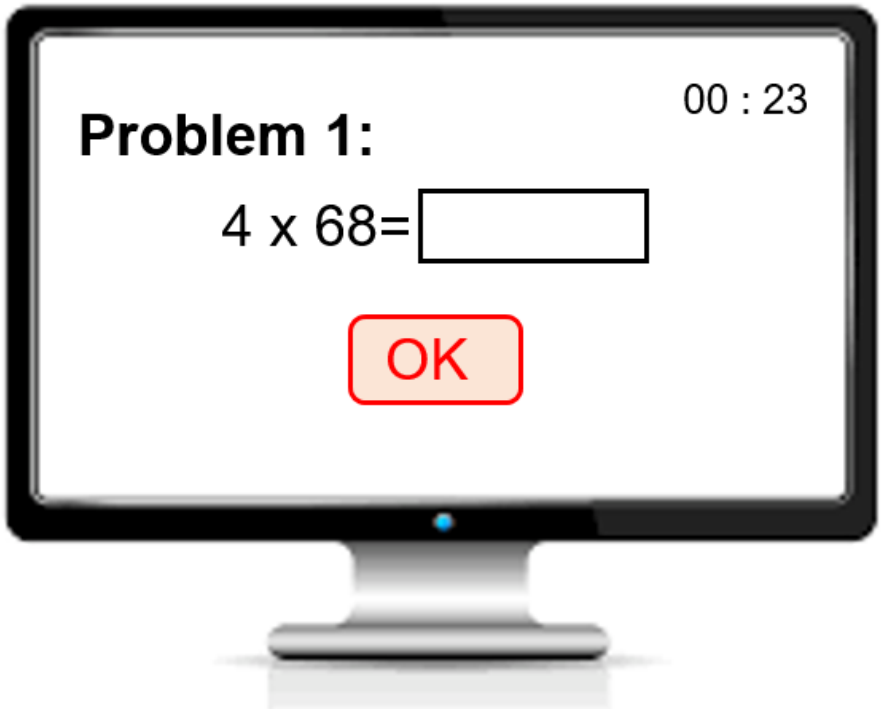
Experiment · Design · Step 7

- Ask how they would have decided if the fixed payment different.
  - *prefer the treatment-specific variable pay or the fixed payment*

$$\{50,100,150,\ldots\ldots,800\}$$

Experiment · Design · Step 8

- Work for **10 minutes** on the same task as step 3.



Experiment · Design · Step 9

- Assess performance in step 8.
  - *How much effort did you exert?*
  - *How stressed did you feel?*
  - *How exhausted did you get?*
- Answer these questions on a seven-point Likert scale.
  - *1: not at all*

  - *7: very much*

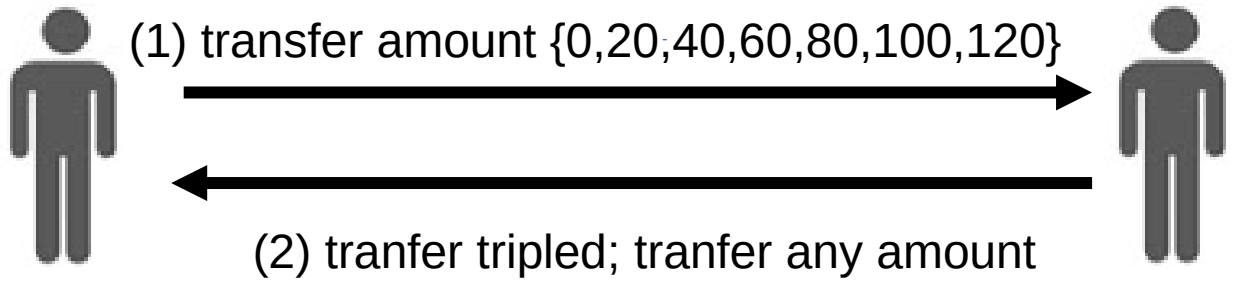
Experiment · Design · Step 10

- Elicit **social preferences** using a simple Trust game.
  - A two-player,sequential game

    (1) contingent response method

    (2) the actual transfer

    (3) both roles required



the first mover
endowment:120 points

the second mover
endowment:120 points

Experiment · Design · Step 11

- Elicit **risk preferences** using simple lottery choices.
  - make a decision for each row
  - determine a row randomly for payment.

row	choice A	choice B
1	25	(400,0)
2	50	(400,0)
3	75	(400,0)
4	100	(400,0)
5	125	(400,0)
6	150	(400,0)
7	175	(400,0)
8	200	(400,0)
9	225	(400,0)
10	250	(400,0)
11	275	(400,0)
12	300	(400,0)
13	325	(400,0)
14	350	(400,0)
15	375	(400,0)

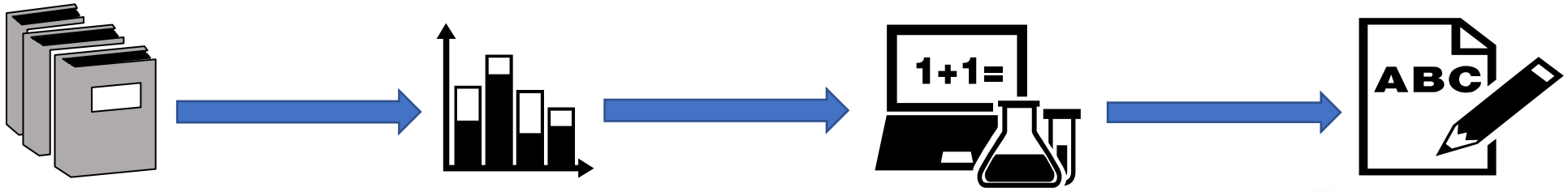
Experiment · Design · Step 12

- Elicit **risk attitude** on an 11-point scale.
  - *How do you see yourself: "Are yougenerally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on thescale, where the value 0 means: 'unwilling to take risks' and the value 10 means: 'fully prepared to take risks'."* (by 2004 wave of the German Socio-Economic Panel Study)
- Answer these questions on a seven-point Likert scale.
  - *0: unwilling to take risks*
  - *10: fully prepared to take risks*

Experiment · Design · Final Questinare

- Socioeconomic characteristics
  - gender,age,nationality,marital status, and parents' eduction
- Educational achievement
  - grades and major field of Abitur (university entrance examination)
  - high school graduation year
  - last mathematical grade in high school
- Verbal IQ test
- Personal attitudes test

Experiment · Design · Brief Summary



Productivity Indicators
step 1, 2, 3

assessment
step 4, 5

sorting experiment
(decision, strategetic change,game)
step 6, 7, 8

personal information
step 9,10,11,12

Experiment · Procedure

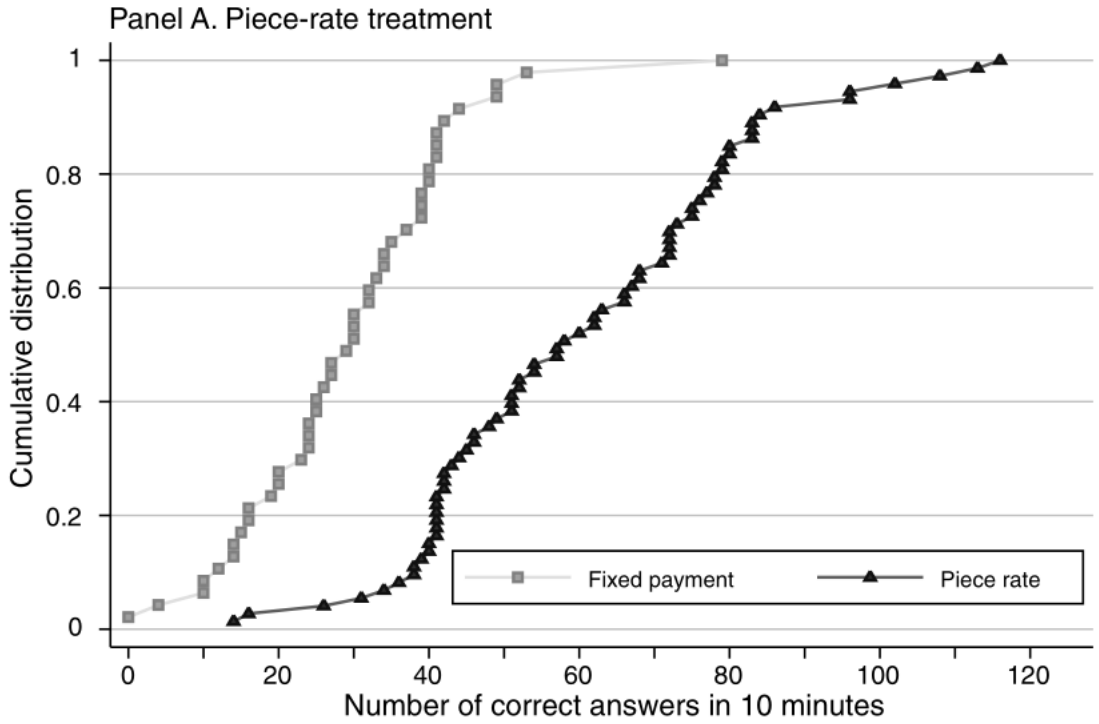
- Subjects: students from the University of Bonn
- 360 subjects in total
- Software: z-Tree
- About 90 minutes for 1 session
- 18 sessions for 3 treatments
- 10 points=0.17 euros (about 1.4 RMB now)
- Average earnings:21.20 euros (about 166.5 RMB now)

PART 3: Results

- Output
- Sorting

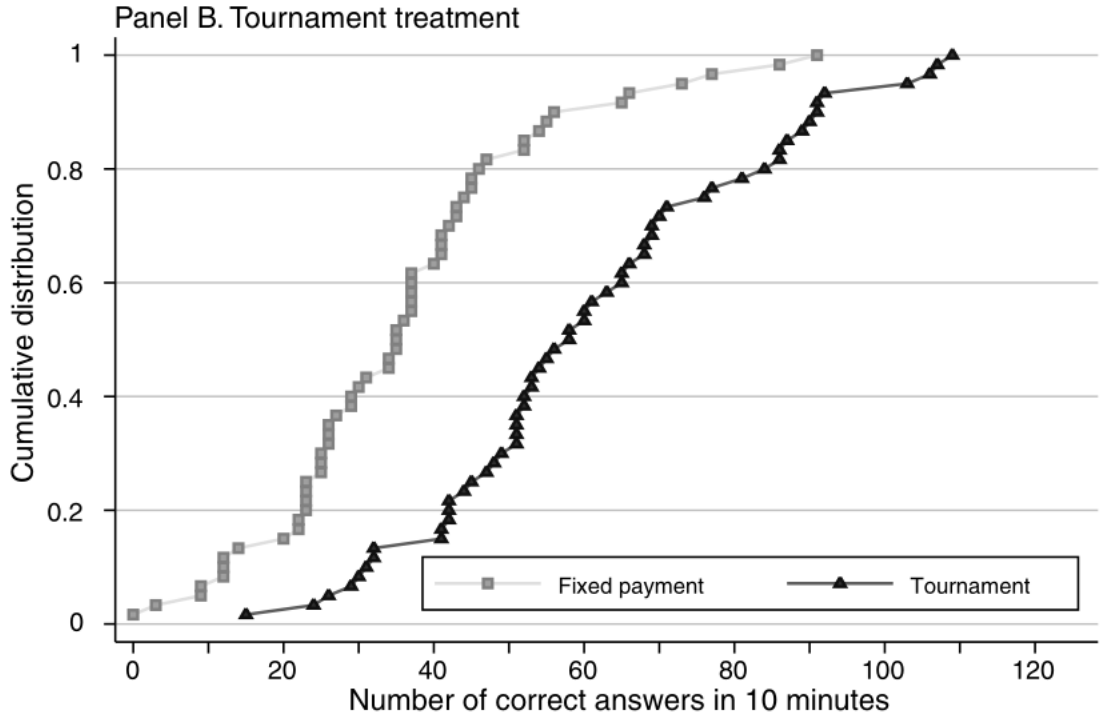
Results: Output · Numbers

- The piece-rate scheme is significantly higher than that under the fixed-wage regime.



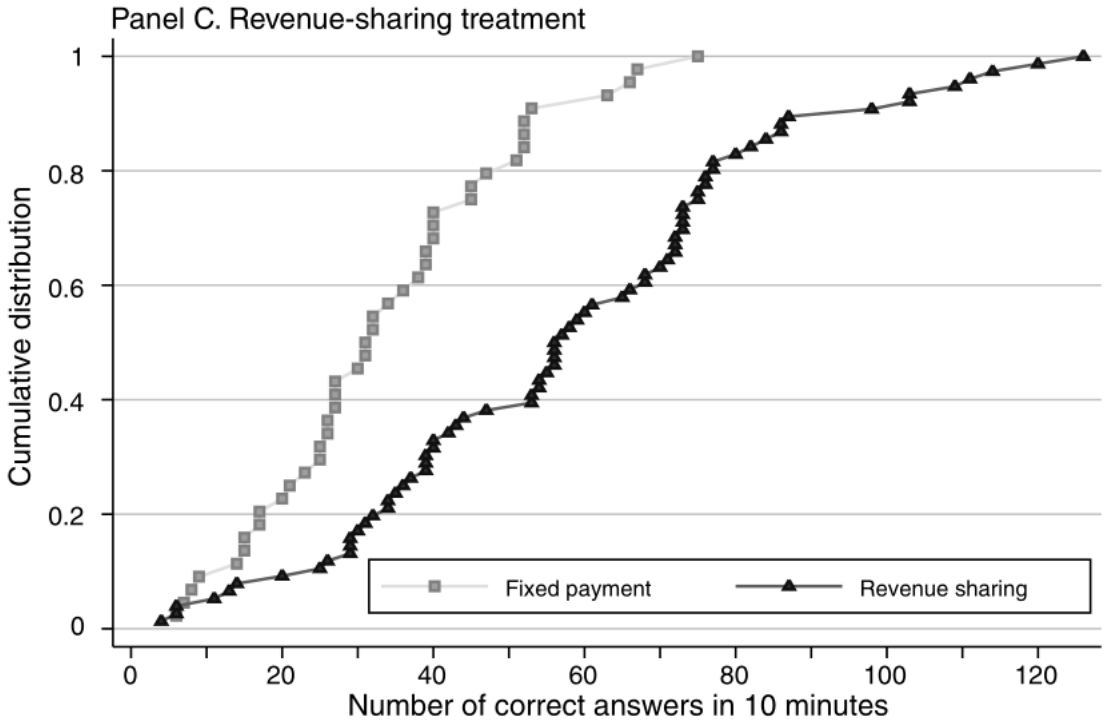
Results: Output · Numbers

- The tournament scheme is significantly higher than that under the fixed-wage regime.



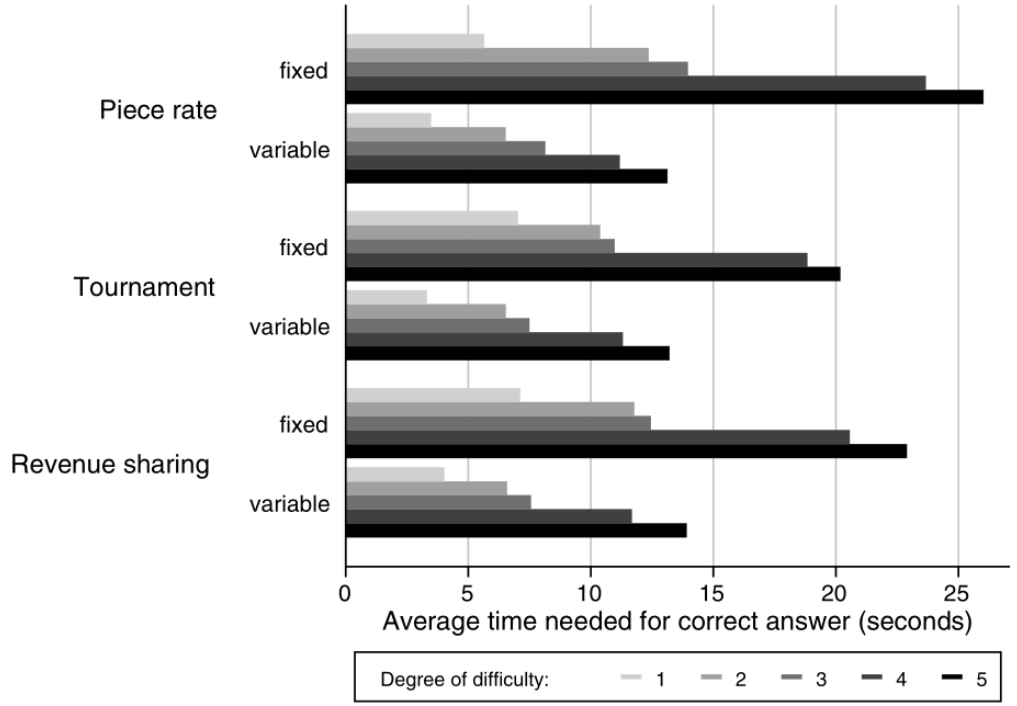
Results: Output · Numbers

- The revenue-sharing scheme is significantly higher than that under the fixed-wage regime.



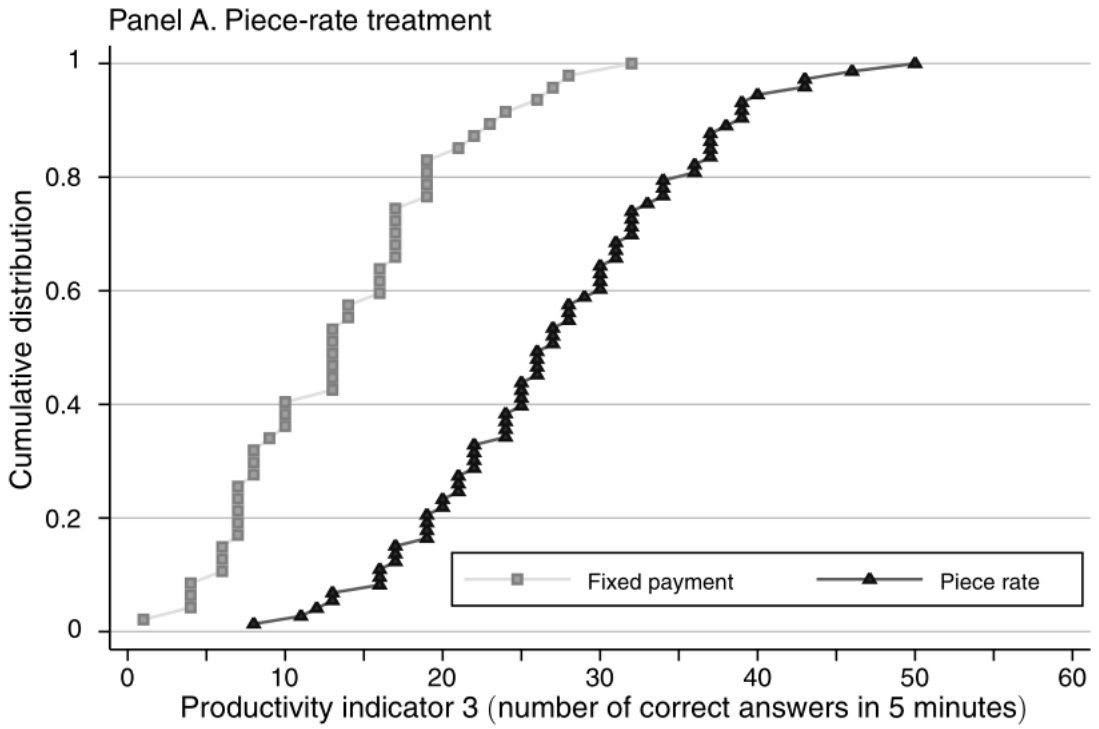
Results: Output · Time

- All variable-pay shemes are significantly higher than that under the fixed-wage regime.



Results: Sorting · Productivity

- the more productive a worker, the more likely he self-selects into the variable-pay scheme.



Results: Sorting · Productivity

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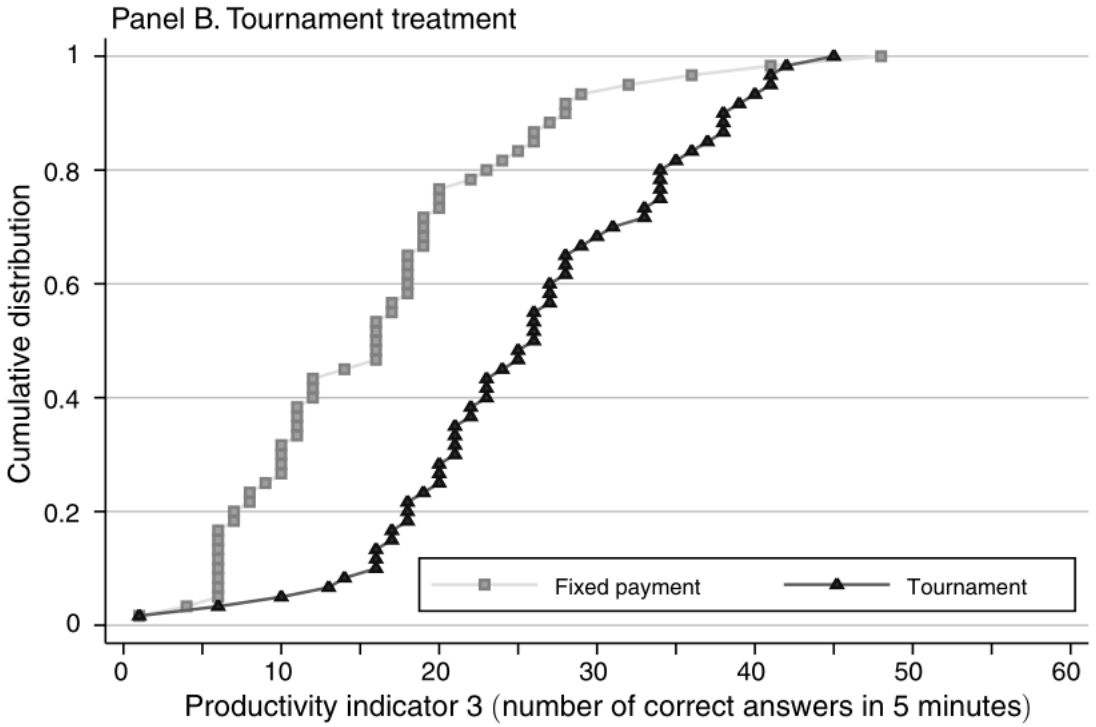

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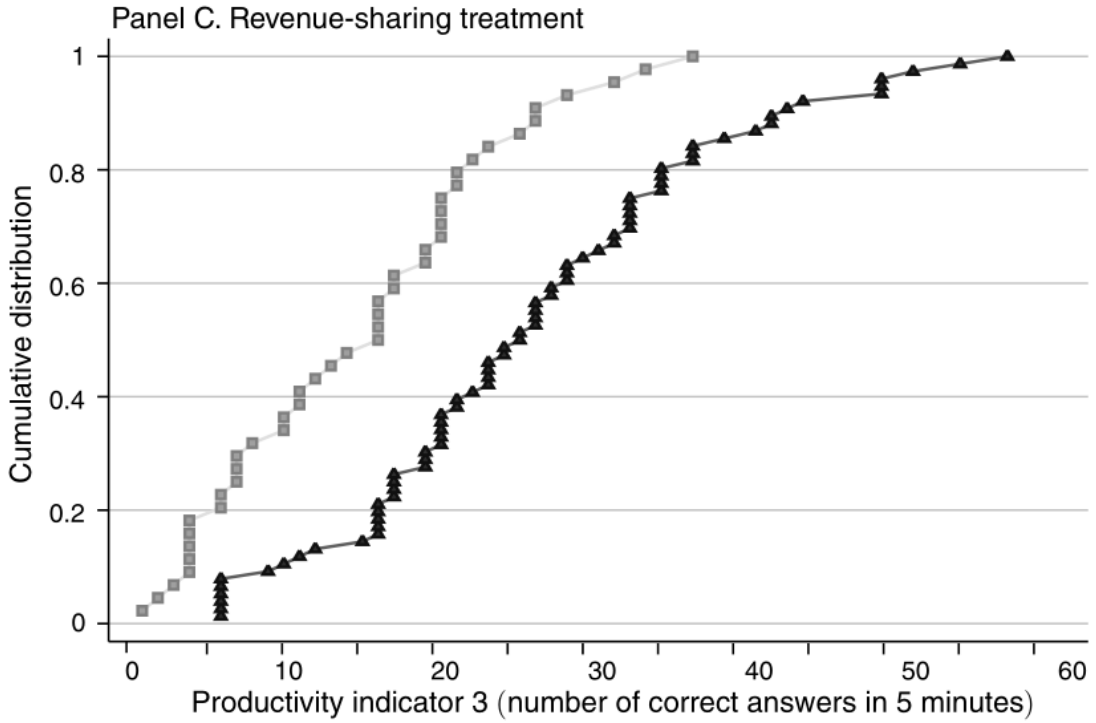
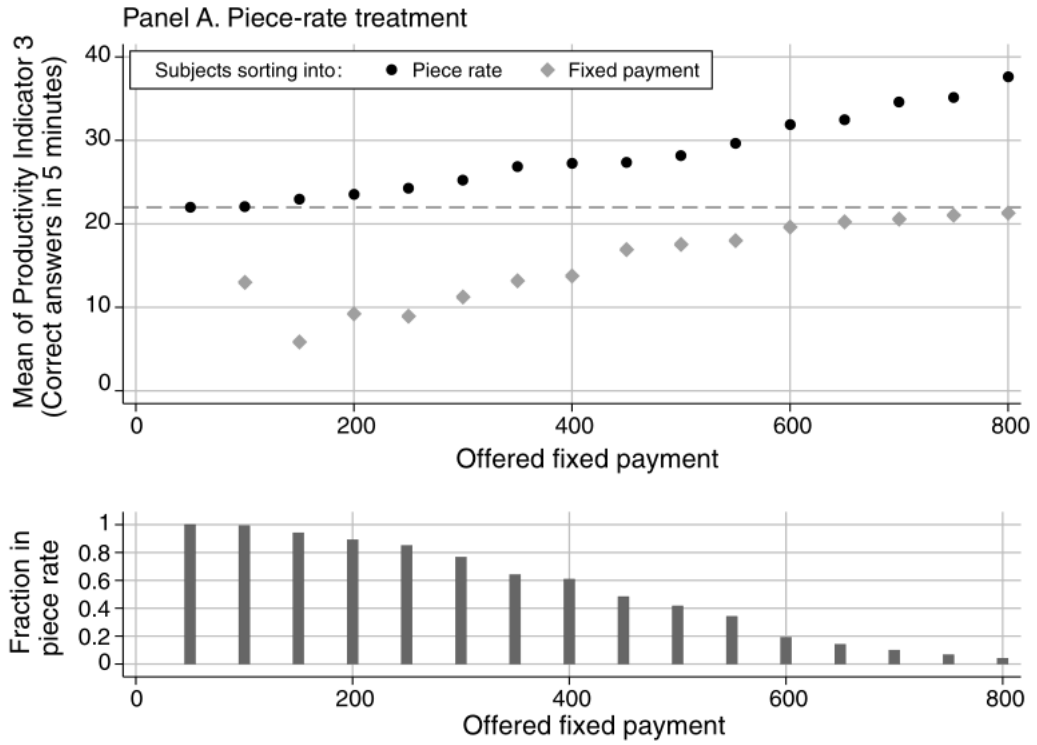


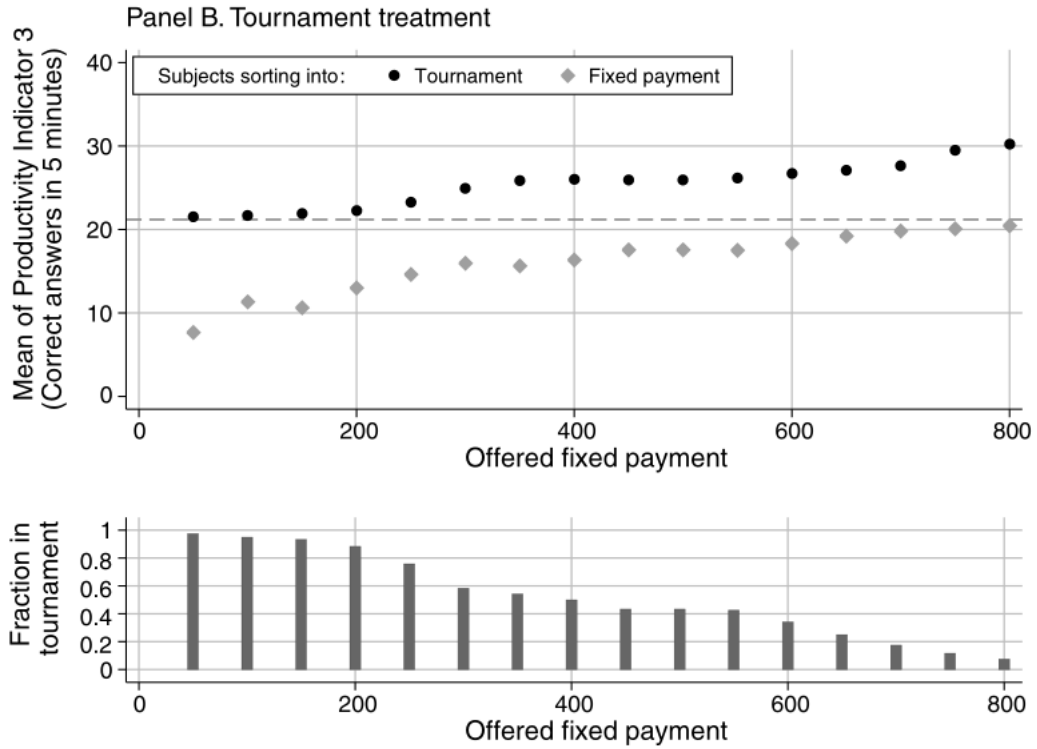
Results: Sorting · Productivity

- Sorting pattern: As the fixed wage becomes more attractive, fewer and fewer subjects self-select into variable pay.



Results: Sorting · Productivity

- Sorting pattern: As the fixed wage becomes more attractive, fewer and fewer subjects self-select into variable pay.



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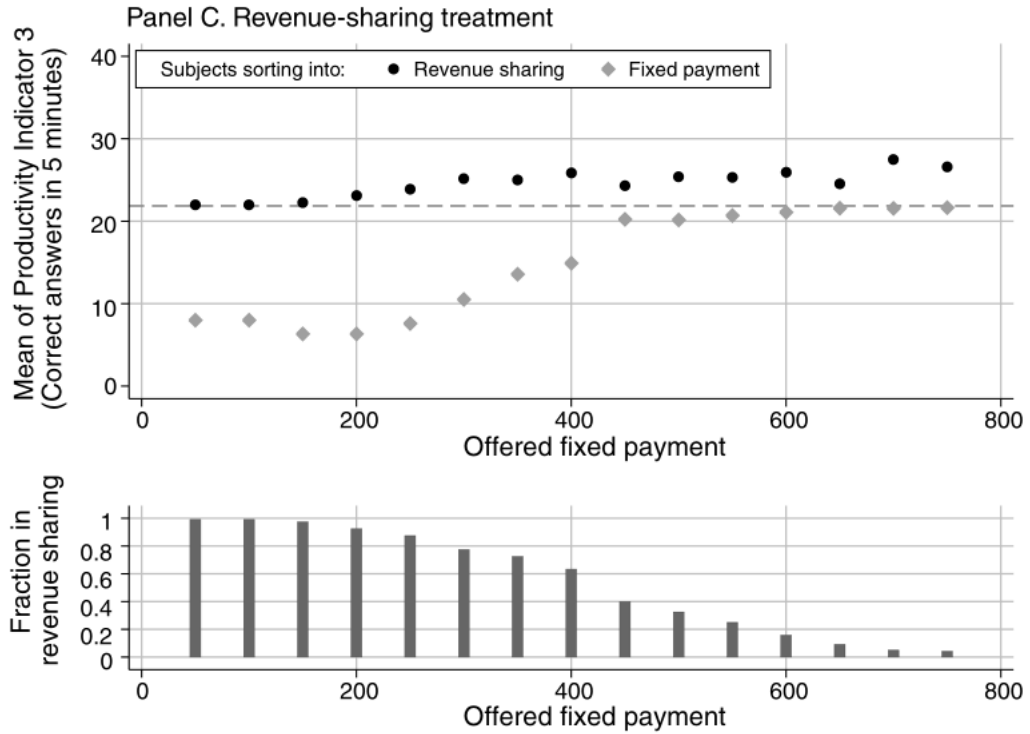

Results: Sorting · Risk attitudes

- **Theory prediction**
  - The expected utility from variable pay is lower for risk-averse subjects than for risk-neutral or risk-loving subjects→expect the subjects are **less** likely to select into variable pay the **more risk averse** they are.
  - the effects strong in tournament since earnings uncertainty is most pronounced in this condition for two reasons:
    - the spread of potential earnings is higher
    - the contestant's ability is unknown

Results: Sorting · Risk attitudes

- Empirical Results

TABLE 2—DETERMINANTS OF SORTING

Dependent variable	1 if piece rate (1)	1 if tournament (2)	1 if revenue sharing (3)	1 if variable pay (4)
Productivity indicator 3	0.044***	0.018***	0.016***	0.023***
	[0.009]	[0.007]	[0.003]	[0.004]
Risk attitude	0.053***	0.087***	0.008	0.054***
	[0.015]	[0.032]	[0.013]	[0.014]
Relative self-assessment	0.003	−0.027*	−0.020	−0.015*
	[0.015]	[0.015]	[0.014]	[0.009]
Trust (amount sent)	0.002*	0.002	−0.001	0.001
	[0.001]	[0.002]	[0.002]	[0.001]
Reciprocity	0.006	0.012	0.063	0.012
	[0.041]	[0.098]	[0.046]	[0.034]
1 if female	0.029	−0.157	−0.097	−0.068
	[0.121]	[0.137]	[0.075]	[0.059]
Pseudo R^2	0.410	0.307	0.204	0.268
Observations	120	120	120	360

Results: Sorting · Relative self-assessment

- **Theory prediction**
  - piece rates: depend only on one's own performance and are independent of other workers' outputs.
  - beliefs about other workers' productivity are irrelevant for piece rates decision but affect tournament decision.
  - relative self-assessment affects decision in the tournament while no effect in piece-rate.

Results: Sorting · Relative self-assessment

- Empirical results
  - The raw correlations might predominantly reflect productivity sorting given that self-assessed ranks and true ranks are highly correlated.

TABLE 1—CORRELATION AMONG INDEPENDENT VARIABLES

	Productivity indicator 3	Risk attitude	Relative self-assessment	Trust (amount sent)	Reciprocity	1 if female
Productivity indicator 3	1.0000					
Risk attitude	0.0874	1.0000				
Relative self-assessment	−0.6953	−0.1046	1.0000			
Trust (amount sent)	−0.0107	0.1033	−0.0110	1.0000		
Reciprocity	−0.1412	−0.0666	0.0987	0.4691	1.0000	
1 if female	−0.2644	−0.2451	0.2160	−0.1245	0.1583	1.0000

Notes: The table shows the partial correlations between the independent variables.

Results: Sorting · Relative self-assessment

- Empirical results

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Results: Sorting · Social preferences

- **Theory**
  - The coexistence of selfish and reciprocally motivated agents changes the optimality conditions of difference types of contracts.
  - Contracts that are inefficient if all actors are selfish may achieve surprisingly high levels of efficiency when there are some fair-minded people.
  - Given the relevance of social preferences for optimal contracting it is important to understand whether they also affect the sorting of agents.

Results: Sorting · Social preferences

- Empirical results
  - Neither trust or reciprocity significantly determine the sorting decision except for a small effect for trust in the piece-rate treatment

TABLE 2—DETERMINANTS OF SORTING

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Results: Sorting · Gender

- Women are more likely than men to prefer noncompetitive and nonvariable pay, which may mean lower average wages for women than for men

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Results: Sorting · Gender

- Maybe conditional probability is not a useful measure for answering the sex difference question.
- If there are important gender differences in attributes that we condition on and that affect the sorting decision, then gender differences in sorting choices might be reflected in a significant estimates of gender specific attributes.

TABLE 1—CORRELATION AMONG INDEPENDENT VARIABLES

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Risk attitude	0.0874	1.0000				
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Reciprocity	−0.1412	−0.0666	0.0987	0.4691	1.0000	
1 if female	−0.2644	−0.2451	0.2160	−0.1245	0.1583	1.0000

Notes: The table shows the partial correlations between the independent variables.

Results: Sorting · Gender

- Gender difference is very strong in the piece-rate treatment and in the tournament treatment, and somewhat smaller in the revenue-sharing treatment (20 percentage)

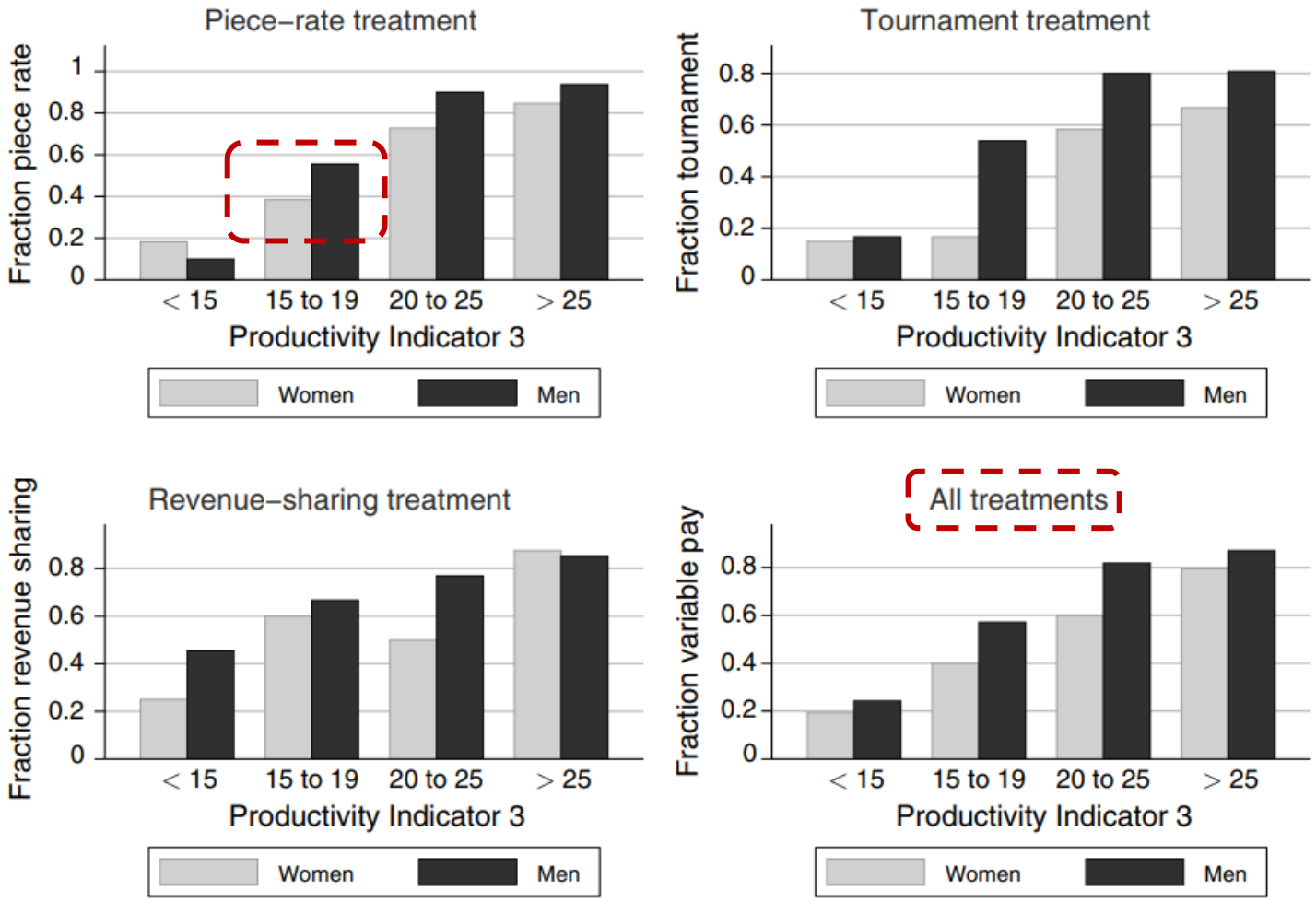
TABLE 3—PROPORTIONS OF MEN AND WOMEN SORTING INTO VARIABLE PAY SCHEMES

	Piece rate	Tournament	Revenue sharing	All variable
Women	47.5	37.3	54.0	46.4
Men	73.8	62.3	73.7	69.8

Notes: The table shows the percentages of men and women who select into the variable pay schemes.

Results: Sorting · Gender

- Stepwise add controls for productivity and various preferences and attitudes→the gender difference remains significant if we **only condition on productivity**.
- The figure shows what fraction of men and women with a particular productivity level select into the variable payment scheme



Results: Sorting · Robustness and Next

- **Robustness**: personality traits itself could be an important driver of self-selection and it could be correlated with our other characteristics like risk attitudes, but our results are robust to controlling for personality traits using a variant called Big-Five inventory .
- **Next**: assume that attitudes and preferences affect the sorting decisions of all subjects in the same way→to what extent particular personal characteristics affect the sorting decision depends on the location in the productivity distribution.

Results: Sorting · Marginal types

TABLE 4—DETERMINANTS OF SORTING AT THE MARGIN

Dependent variable	Piece-rate treatment 1 if piece rate chosen			Tournament treatment 1 if tournament chosen		Revenue-sharing treatment 1 if revenue sharing chosen	
	Marginal type (productivity) (1)	Marginal type (response time) (2)	Nonmarginal type (response time) (3)	Marginal type (response time) (4)	Nonmarginal type (response time) (5)	Marginal type (response time) (6)	Nonmarginal type (response time) (7)
Productivity indicator 3	0.046*** [0.012]	0.053*** [0.012]	0.036*** [0.012]	0.013 [0.012]	0.023* [0.012]	0.023*** [0.005]	0.001 [0.005]
Risk attitude	0.073** [0.030]	0.076*** [0.027]	−0.017 [0.044]	0.139*** [0.044]	0.034 [0.051]	0.033 [0.030]	−0.007 [0.007]
Relative self-assessment	0.008 [0.018]	0.015 [0.033]	−0.020 [0.023]	−0.011 [0.022]	−0.046** [0.021]	−0.023 [0.016]	−0.023 [0.016]
Trust (amount sent)	0.001 [0.002]	0.003 [0.003]	0.001 [0.002]	0.002 [0.003]	0.003 [0.003]	−0.004*** [0.002]	0.002** [0.001]
Reciprocity	−0.001 [0.041]	0.005 [0.068]	0.022 [0.042]	−0.014 [0.098]	0.069 [0.112]	0.077 [0.050]	0.028 [0.016]
1 if female	0.001 [0.154]	0.121 [0.160]	−0.160 [0.187]	−0.086 [0.207]	−0.259 [0.197]	−0.029 [0.084]	0.011 [0.035]
Pseudo R^2	0.215	0.348	0.529	0.283	0.457	0.220	0.401
Observations	76	60	60	62	58	61	59

Results: Sorting · Marginal types

TABLE 4—DETERMINANTS OF SORTING AT THE MARGIN

Dependent variable	Piece-rate treatment 1 if piece rate chosen			Tournament treatment 1 if tournament chosen		Revenue-sharing treatment 1 if revenue sharing chosen	
	Marginal type (productivity) (1)	Marginal type (response time) (2)	Nonmarginal type (response time) (3)	Marginal type (response time) (4)	Nonmarginal type (response time) (5)	Marginal type (response time) (6)	Nonmarginal type (response time) (7)
Productivity indicator 3	0.046*** [0.012]	0.053*** [0.012]	0.036*** [0.012]	0.013 [0.012]	0.023* [0.012]	0.023*** [0.005]	0.001 [0.005]
Risk attitude	0.073** [0.030]	0.076*** [0.027]	−0.017 [0.044]	0.139*** [0.044]	0.034 [0.051]	0.033 [0.030]	−0.007 [0.007]
Relative self-assessment	0.008 [0.018]	0.015 [0.033]	−0.020 [0.023]	−0.011 [0.022]	−0.046** [0.021]	−0.023 [0.016]	−0.023 [0.016]
Trust (amount sent)	0.001 [0.002]	0.003 [0.003]	0.001 [0.002]	0.002 [0.003]	0.003 [0.003]	−0.004*** [0.002]	0.002** [0.001]
Reciprocity	−0.001 [0.041]	0.005 [0.068]	0.022 [0.042]	−0.014 [0.098]	0.069 [0.112]	0.077 [0.050]	0.028 [0.016]
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Risk attitude	0.073** [0.030]	0.076*** [0.027]	−0.017 [0.044]	0.139*** [0.044]	0.034 [0.051]	0.033 [0.030]	−0.007 [0.007]
Relative self-assessment	0.008 [0.018]	0.015 [0.033]	−0.020 [0.023]	−0.011 [0.022]	−0.046** [0.021]	−0.023 [0.016]	−0.023 [0.016]
Trust (amount sent)	0.001 [0.002]	0.003 [0.003]	0.001 [0.002]	0.002 [0.003]	0.003 [0.003]	−0.004*** [0.002]	0.002** [0.001]
Reciprocity	−0.001 [0.041]	0.005 [0.068]	0.022 [0.042]	−0.014 [0.098]	0.069 [0.112]	0.077 [0.050]	0.028 [0.016]
1 if female	0.001 [0.154]	0.121 [0.160]	−0.160 [0.187]	−0.086 [0.207]	−0.259 [0.197]	−0.029 [0.084]	0.011 [0.035]
Pseudo R^2	0.215	0.348	0.529	0.283	0.457	0.220	0.401
Observations	76	60	60	62	58	61	59

Results: Effort Provision and Output Changes

- **Although our main focus is on sorting, still interesting to know whether participants' performance is affected by different incentives.**
- **Prediction**
  - Subjects in the variable-pay schemes should provide at least as much effort as subjects who are paid according to a fixed-payment contract. (b.c. variable-payment schemes add an explicit **reward** for effort.
  - Subjects in variable-pay schemes feel **more stressed** and get **more exhausted** than fixed payment.

Results: Effort Provision

- **Before sorting decision:** five-minute test for productivity indicator in step 3
- **After sorting decision:** ten-minute under different schemes

TABLE 5—EFFORT, STRESS, AND EXHAUSTION

	Before sorting decision			After sorting decision		
	Piece rate (mean) (1)	Fixed (mean) (2)	M–W test (p-value) (3)	Piece rate (mean) (4)	Fixed (mean) (5)	M–W test (p-value) (6)
Panel A. Effort, stress and exhaustion in piece-rate treatment						
Effort	5.60	5.49	0.596	6.03	4.26	< 0.001
Stress	5.48	5.62	0.502	5.71	3.51	< 0.001
Exhaustion	3.05	2.74	0.317	4.07	2.68	< 0.001
Observations	73	47		73	47	

Results: Effort Provision

TABLE 5—EFFORT, STRESS, AND EXHAUSTION

	Before sorting decision			After sorting decision		
	Piece rate (mean) (1)	Fixed (mean) (2)	M–W test (p-value) (3)	Piece rate (mean) (4)	Fixed (mean) (5)	M–W test (p-value) (6)
Panel A. Effort, stress and exhaustion in piece-rate treatment						
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Stress	5.48	5.62	0.502	5.71	3.51	< 0.001
Exhaustion	3.05	2.74	0.317	4.07	2.68	< 0.001
Observations	73	47		73	47	

Results: Effort Provision

	Before sorting decision			After sorting decision		
	Piece rate (mean) (1)	Fixed (mean) (2)	M–W test (p-value) (3)	Piece rate (mean) (4)	Fixed (mean) (5)	M–W test (p-value) (6)
Panel A. Effort, stress and exhaustion in piece-rate treatment						
Effort	5.60	5.49	0.596	6.03	4.26	< 0.001
Stress	5.48	5.62	0.502	5.71	3.51	< 0.001
Exhaustion	3.05	2.74	0.317	4.07	2.68	< 0.001
Observations	73	47		73	47	

	Before sorting decision			After sorting decision		
	Tournament (mean) (1)	Fixed (mean) (2)	M–W test (p-value) (3)	Tournament (mean) (4)	Fixed (mean) (5)	M–W test (p-value) (6)
Panel B. Effort, stress and exhaustion in tournament treatment						
Effort	5.57	5.37	0.264	6.23	4.70	< 0.001
Stress	5.43	5.48	0.524	5.80	3.95	< 0.001
Exhaustion	2.93	2.93	0.698	3.67	3.30	< 0.268
Observations	60	60		60	60	

	Before sorting decision			After sorting decision		
	Revenue sharing (mean) (1)	Fixed (mean) (2)	M–W test (p-value) (3)	Revenue sharing (mean) (4)	Fixed (mean) (5)	M–W test (p-value) (6)
Panel C. Effort, stress and exhaustion in revenue-sharing treatment						
Effort	5.54	5.39	0.536	5.66	4.48	< 0.001
Stress	5.41	5.61	0.241	5.37	3.91	< 0.001
Exhaustion	2.57	2.50	0.806	3.63	2.84	< 0.020
Observations	76	44		76	44	

Results: Output Changes

- Compare output in the five-minute work period with output in th e first five minutes of the ten-minute work period for three differ ent variable-payment schemes.
- **Average increase in output**
  - Tournament rate treatment: 3.4 more answers, $p<0.002$
  - Piece rate treatment: 1.8 more answers, $p<0.007$
  - Revenue-sharing treatment: 1.5 more answers, $p<0.035$

PART 4: Discussion

- Outside the lab
- Main results
- Implications

Discussion: Outside the lab

- Whether the sorting patterns that we observe in the lab generalize qualitativ ely to labor markets outside the lab?
- **Data from German Socio-Economic Panel Study**
  - Productivity proxy: years of education, experience in full-time and part-time employment, and tenure
  - Willingness to take risks
  - Trust attitudes

Discussion: Outside the lab

Dependent variable:	1 if performance evaluation (1)	(2)
Years of schooling	0.022***	−0.001
	[0.002]	[0.003]
Experience full time (in years)	0.011***	0.006***
	[0.002]	[0.002]
Experience full time^2/100	−0.021***	−0.011**
	[0.004]	[0.005]
Experience part time (in years)	−0.002	0.000
	[0.003]	[0.004]
Experience part time^2/100	0.008	0.003
	[0.013]	[0.014]
Tenure (in years)	0.004***	−0.002**
	[0.001]	[0.001]
Age (in years)	−0.006***	−0.003**
	[0.001]	[0.001]
Risk attitude	0.010***	0.008***
	[0.002]	[0.003]
Trust in strangers	−0.001	0.004
	[0.008]	[0.008]
Reciprocity	−0.014**	−0.008
	[0.006]	[0.006]
1 if female	−0.057***	−0.041***
	[0.012]	[0.014]
1 if in public sector		−0.050***
		[0.016]
1 if living in East Germany		0.020
		[0.014]
Firm size dummies	No	Yes
Industry dummies	No	Yes
Occupation dummies	No	Yes
Pseudo R^2	0.0340	0.140
Observations	8,159	8,110

Discussion: Outside the lab

- Cautious about the interpretation of field data since cannot exclude t he possibility of reversed causality.

- Still useful and have similar sorting patterns in lab and field data, su ggesting the importance of multidimensional sorting.

Discussion: Main Results

- **Testing the traditional:** Productivity→Sorting decision
- **More dimensions:** risk attitudes, relative self-assessment, gender
  - Gender differences maybe due to risk attitudes and productivity differences
- **Marginal types:** subjects' location in the productivity distribution
- Importance of preferences and attitudes on the sorting decision depends on t he type of variable incentives

Discussion: Implications

- Designing incentives: not only focus on effort effects but also consid er self-selection.
- Offer different career paths to get right people on the right job.
  - Safety officers should be risk-averse to downside risk for the firm
- In reality, firms can adjust the relative weight of variable pay.
- Also have implications for gender wage gap.

请老师和同学们批评指正！