Can Statistical Discrimination Explain Inequality?

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Research Questions, Motivation and Method

- **Research Questions**
  1. Can *Phelp's* model of statistical discrimination explain inequality in *hiring/allocation?*

     Labor market inequality is mainly caused by allocation to positions
     [e.g. Petersen & Morgan 1995]

  2. Is it the same outcome considering hiring for qualified positions?
  3. Does reduced mobility of (e.g. ethnic migrants) applicants change the outcome?

- **Motivation**
  - Debate in ZFS [Seibert & Solga 2005, 2006 vs. Kalter 2006a, 2006b]
  - Misleading "textbooks" [Cain 1986: 724 vs. England 1992; Kalter 2003]
  - „Rescue" a realistic, plausible, precise, simple, and formalized mechanism [Esser 1999, Hedström & Swedberg 1998,1996]

- **Method**
  - Dynamic micro simulations, implemented in Stata
  - → [Derive corollary hypotheses, to later on test with real data]

Phelp's Measurement Model of Statistical Discrimination: "The Statistical Theory of Racism and Sexism"

- **Hiring – Employers have incomplete information**
  - Investment Decision under uncertainty → interpretation of signals [Phelps 1972; Spence 1973: 355f.; Arrow 1973a, 1973b, 1998; …]

- **Measurement Model – „Phelps Model"** [Phelps 1972, Aigner & Cain 1977]
  - *y* : „Some indicator of skill", e.g. test scores, grades, all „signal" combinations
  - *q* : true skill level; productivity = ability = *job relevant* human capital)
  - α : group mean of q
  - γ : reliability of the test score *y*

- **Employer evaluates each applicant:**

Reliability [0;1] (how good is signal)

$$\hat{q} = E(q|y) = (1-\gamma)\cdot\alpha + \gamma\cdot y$$

Average Product. of Group

Signal (e.g. grade)

Textbooks: … cannot explain group inequality!

However

- **Cain 1986: 724**

Accordingly, for a given y-score [roughly corresponding to "holding X constant" in Model (I)], majority workers receive a higher wage than minority workers for y-scores above the mean, α, and lower wages for y-scores below the mean. Thus, group discrimination, defined by $E(w_1 - w_0) > 0$, is not present.

Allocation to positions

- **England & Lewin 1989: 243**

	Motivation	Creates Group Differences in Earnings
TASTE	Nonpecuniary individual gain in utility	Yes
STATISTICAL	Pecuniary individual gain through saving screening	No

- **Kalter 2006: 146**
  (quoting Cain 1986: 723)

Statistische Diskriminierung im engen Sinne dieser Modelle kann die Residualeffekte somit nicht erklären, solange die Leistungsunterschiede der Gruppen im Mittel nicht wirklich verschieden sind. Was so-

… cannot explain group inequality: True for wages, but not for hiring!

- **Wages**
  - Assume *correct* perception of same average productivity α (no pre-market differences)
  - Assume *non-distorted* perception of signal y (same grades…)
  - Then on average $y_W = y_B = \alpha_W = \alpha_B$
  - Then (some math omitted):

$$\hat{q} = E(q|y) = (1-\gamma)\cdot\alpha + \gamma\cdot y$$

$$wage_W - wage_B = (y-\alpha)(\gamma_W - \gamma_B)$$

- **Hiring – *Not everybody is hired!***
  - Based on the same assumptions
  - Hiring 1 applicant: worker 1 is hired → inequality
  - Hiring 2 applicants: workers 1, 3 hired → no inequality
  - Hire 3 applicants: workers 1, 3, 4 hired → inequality → **discrimination against W group!**

→ **It depends on relation of open positions to applicants**

Table 1: A simple four-worker example

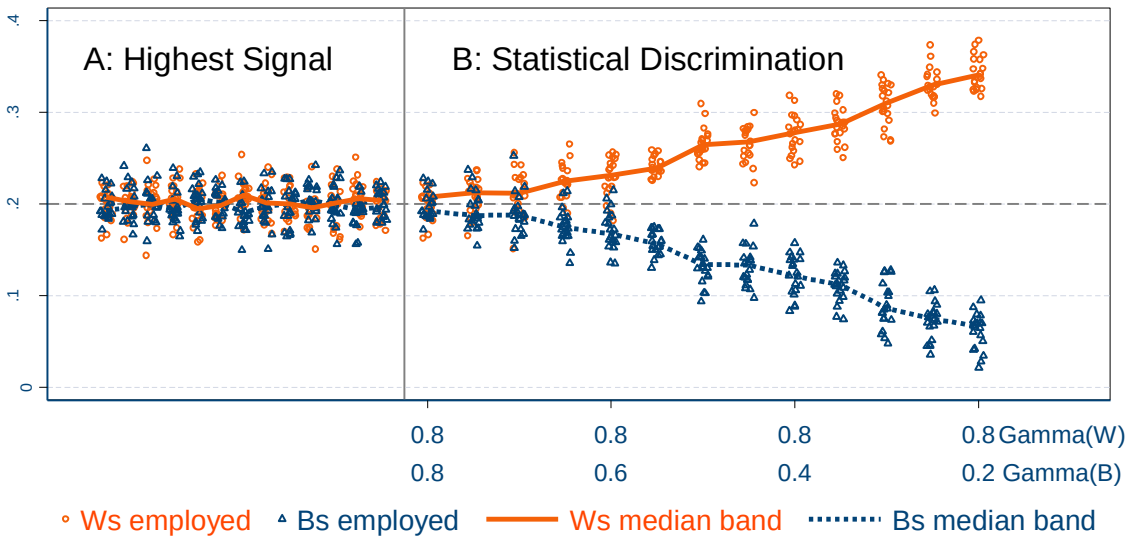
Worker	Group	„Raw“ Signal	**Statistical Disc.**	α	γ
1	W	60	**58**	50	0.8
2		40	**42**		
3	B	60	**54**	50	0.4
4		40	**46**		

Simulation Model

- **Hiring**
  - 100 employers try to hire each one applicant
  - Each of 500 applicants (50% Ws and 50% Bs) randomly apply to ten employers
  - Signals of productivity constant across groups (mean=50; Std. Dev.=10)
  - Sequence of hiring is randomly assigned
  - Once hired, all other applications of the respective applicant are deleted

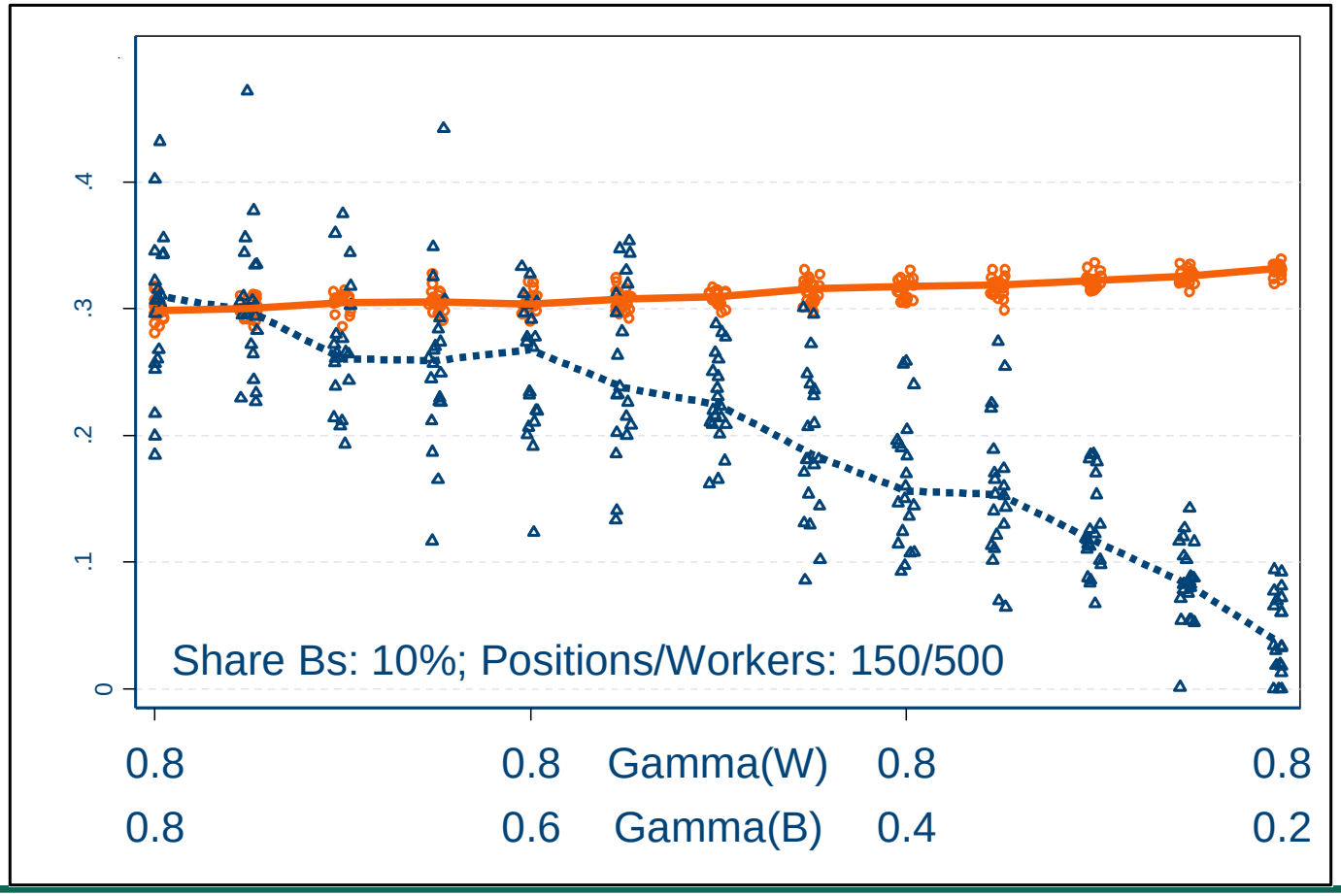
- **Apply two Selection routines**
  - Hiring according to highest signal
  - Statistical discrimination (as in formula above)

- **In all simulations**
  - Repeat each combination of parameters 20 times
  - Count who is hired on group level and calculate share
  - Plot shares from single runs and include median bands



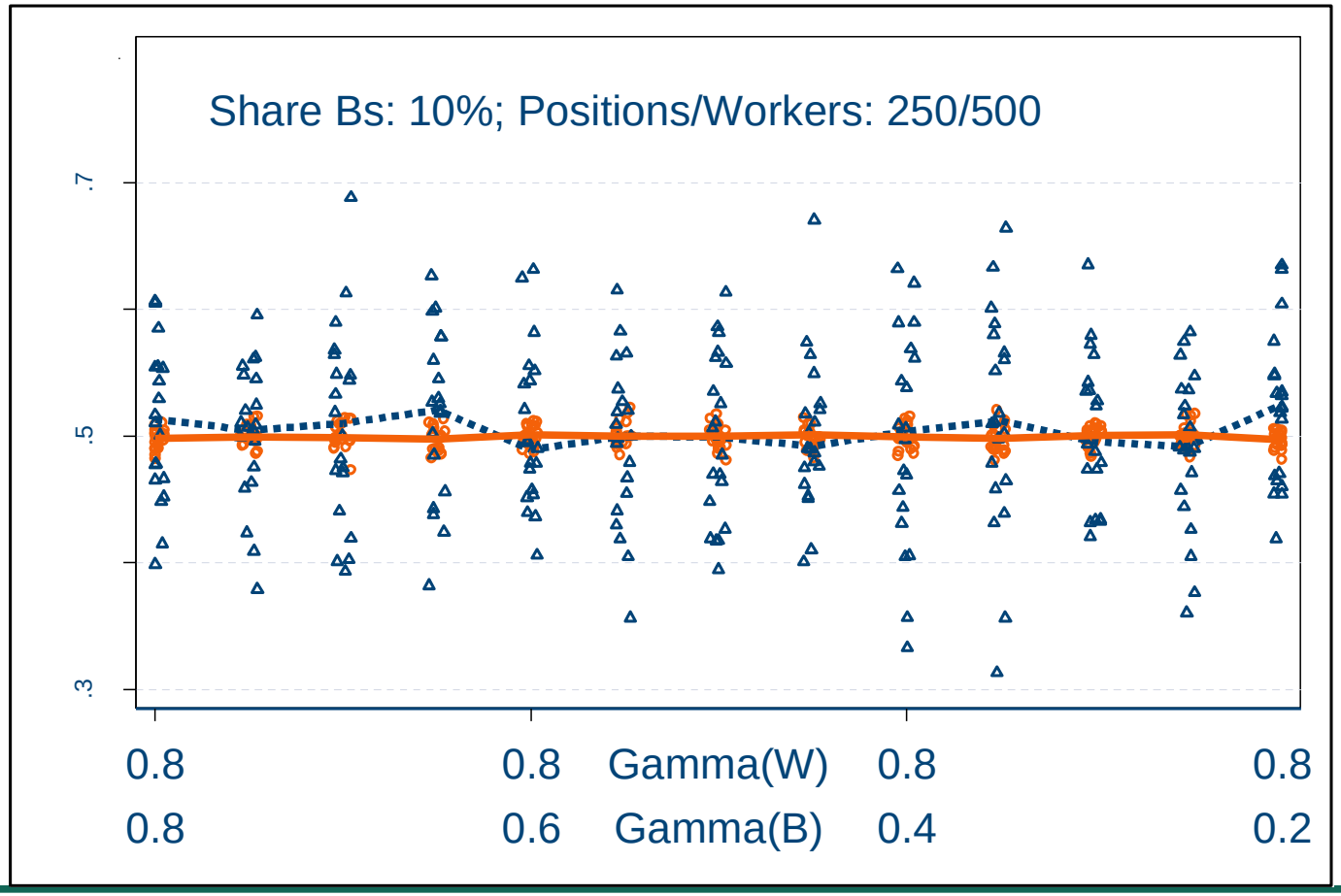
Does it depend on ratio of open positions to applicants?

- **Figure 2a:** **ratio** open positions to applicants **< 1:2** (150:500)
  - → group who is assigned lower reliability is discriminated



Does it depend on ratio of open positions to applicants?

- **Figure 2b: ratio** open positions to applicants **= 1:2** (250:500)
  - → No discrimination



Does it depend on ratio of open positions to applicants?

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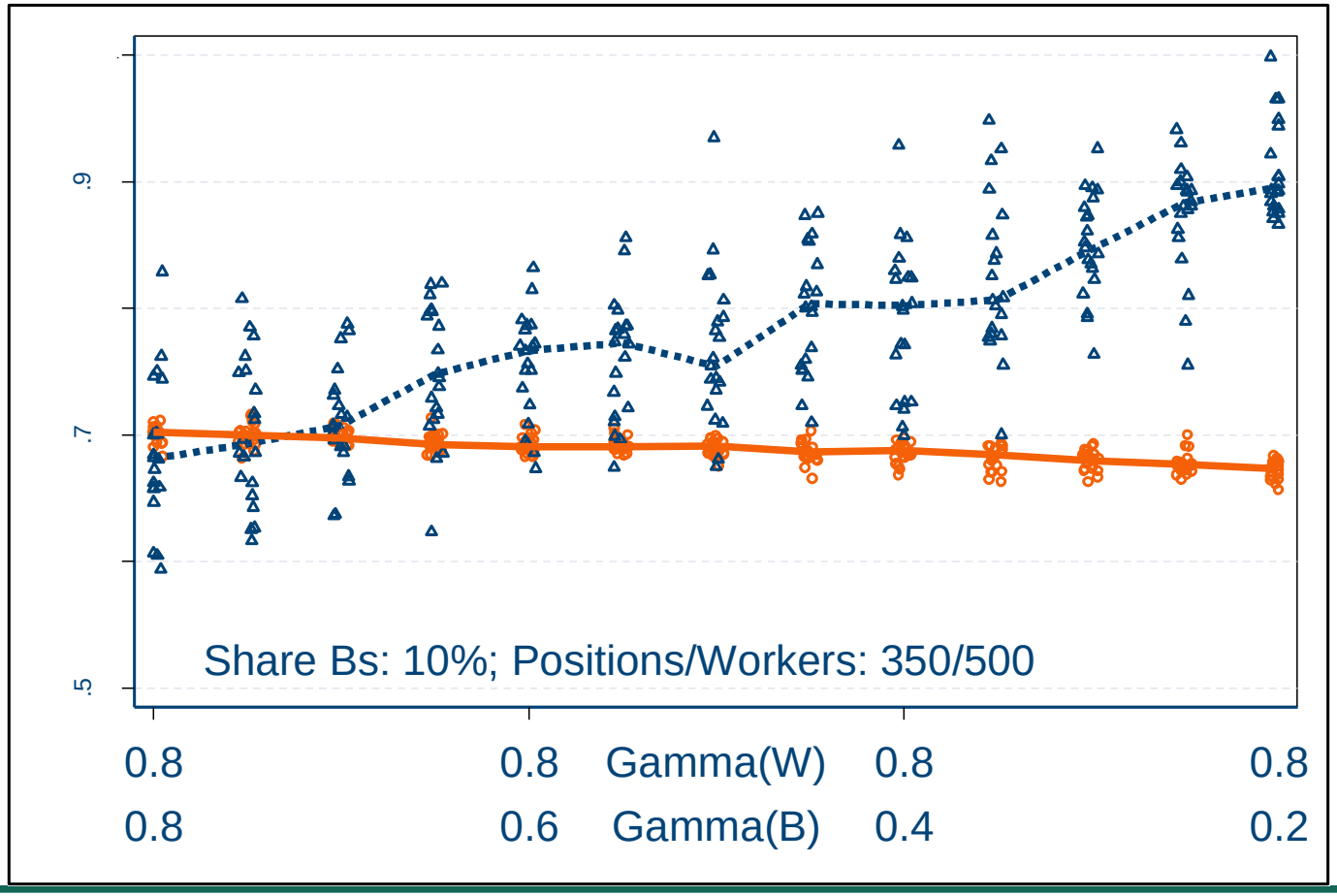
- **Figure 2c:** **ratio** open positions to applicants **> 1:2** (350:500)
  - → Discrimination against majority!

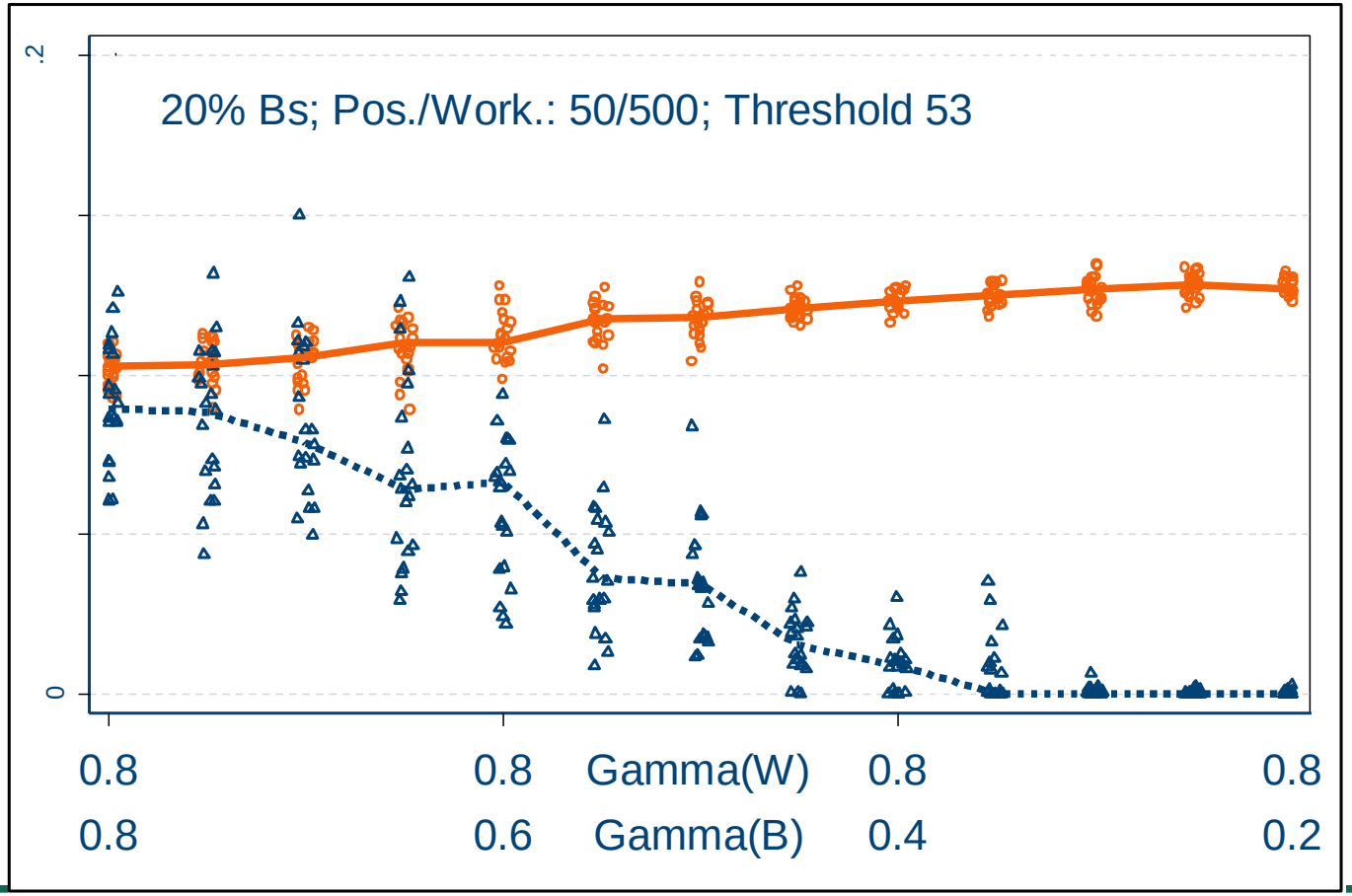


Access to qualified positions

- **Assumption:**
  - A qualified position, requires a productivity above the average (of all applicants)
  - Simulation using two different thresholds:
    - minimum of perceived productivity of 53 vs. 56

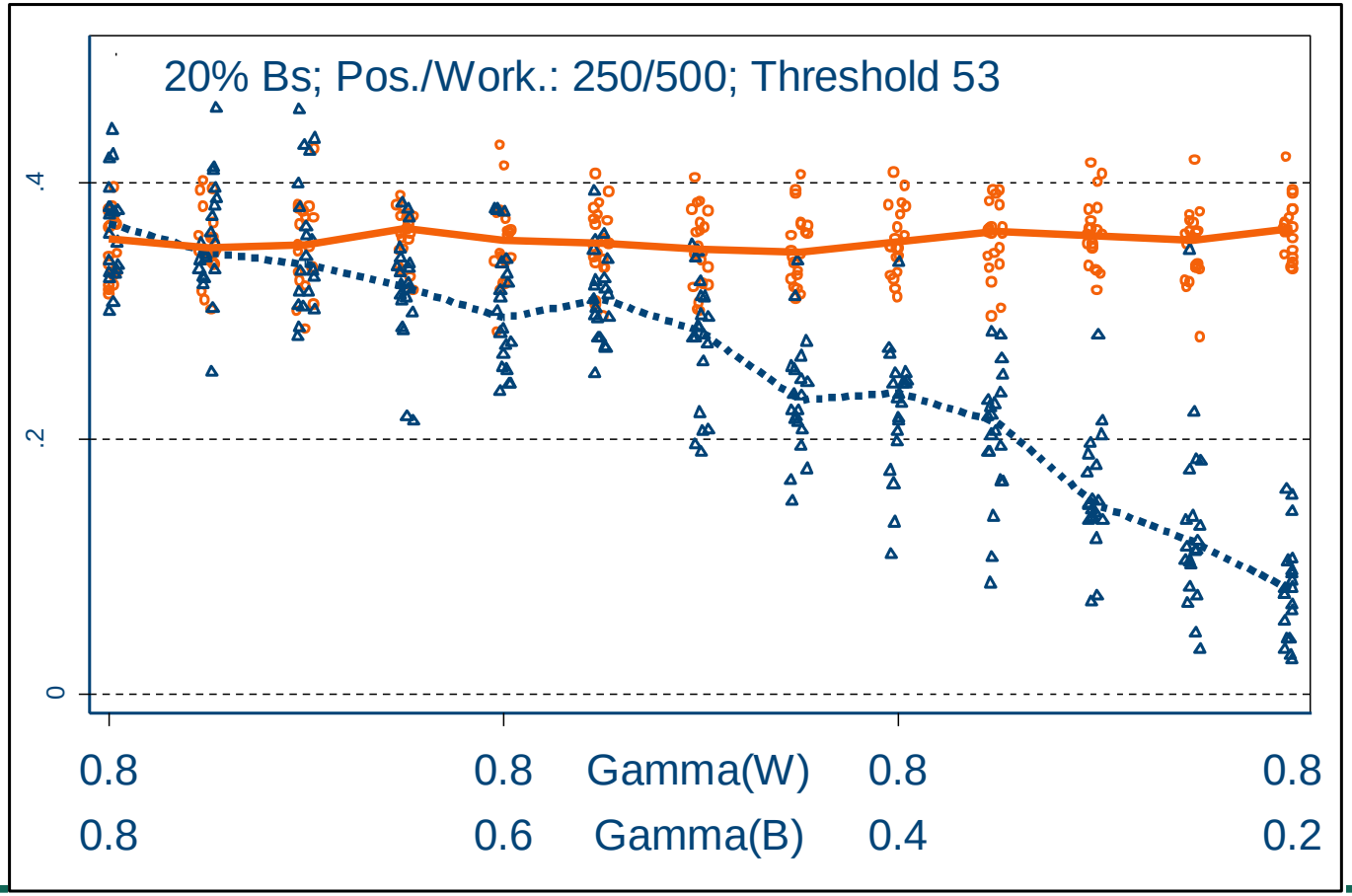
Access to qualified positions

- **Figure 3a: ratio** open positions to applicants **< 1:2** (50:500)
  - Discrimination against minority / lower reliability of signals
  - Even more pronounced, when threshold is higher (not shown)



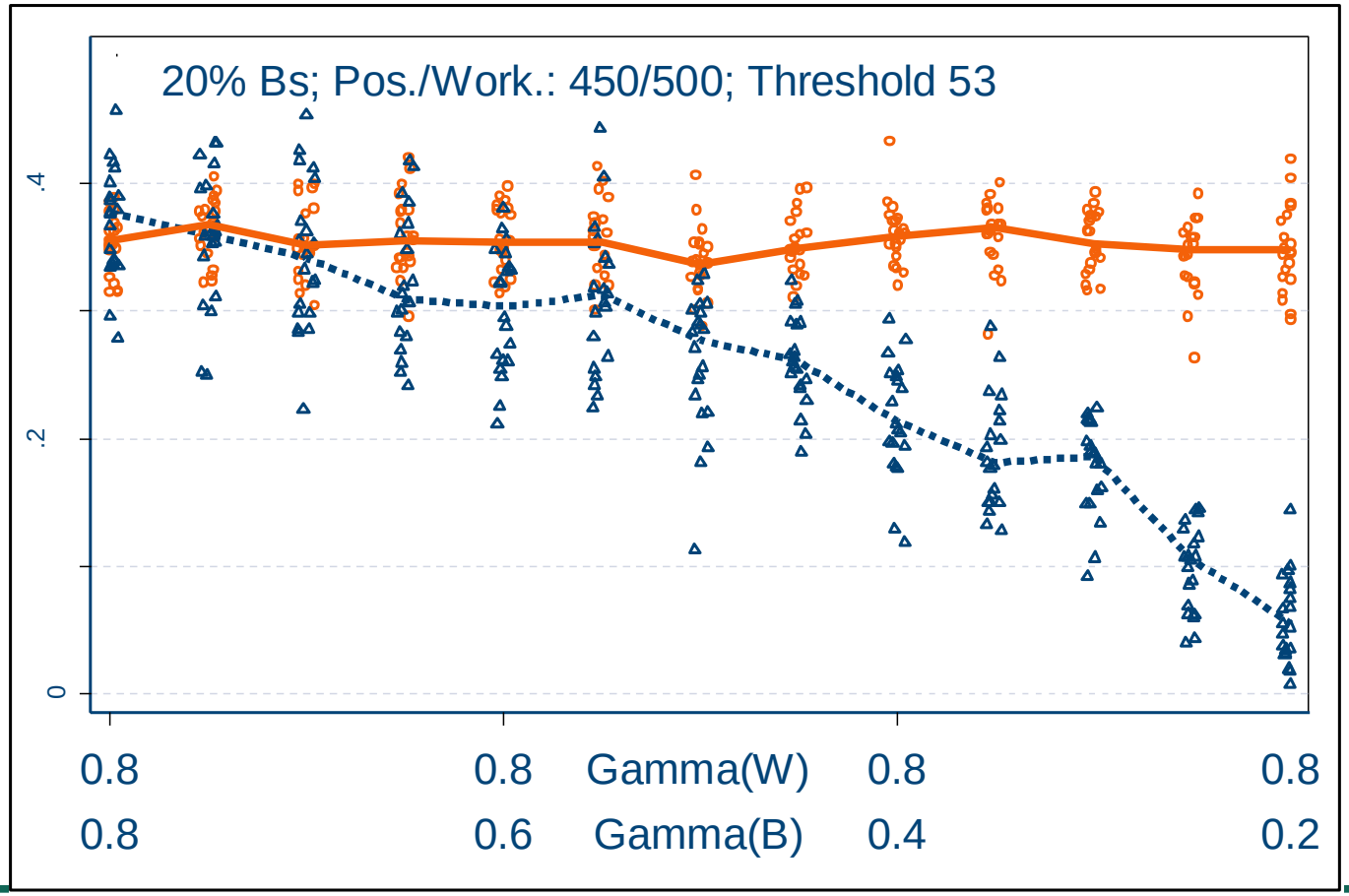
Access to qualified positions

- **Figure 3b: ratio** open positions to applicants **= 1:2** (250:500)
  - Again! Discrimination against Bs
  - Even more pronounced, when threshold is higher (not shown)



Access to qualified positions

- **Figure 3c: ratio** open positions to applicants **> 1:2** (450:500)
  - Again!! Discrimination against Bs
  - Even more pronounced, when threshold is higher (not shown)



Introducing Reduced Mobility of Applicants

- **What happens, if minority group is less informed about open positions, or less mobile?**
  - Or: What happens in a *perfect* vs. *less perfect* labor market, where all/some applicants apply to all/some open positions…

- **Translated into the Simulation Model**
  - Minority group B applies to less employers
  - [Before all workers applied to 10 random employers]
  - Now variation in number of applications: 10, 60, 110, 160 (maximum)

  - Actually, due to the randomization, in reality the numbers are lower:
    - 10 9.7
    - 60 50.2
    - 110 79.7
    - 160 101.3
  - Number of total open positions fixed at 160, 500 applicants, 20% Bs

Introducing Reduced Mobility of Applicants

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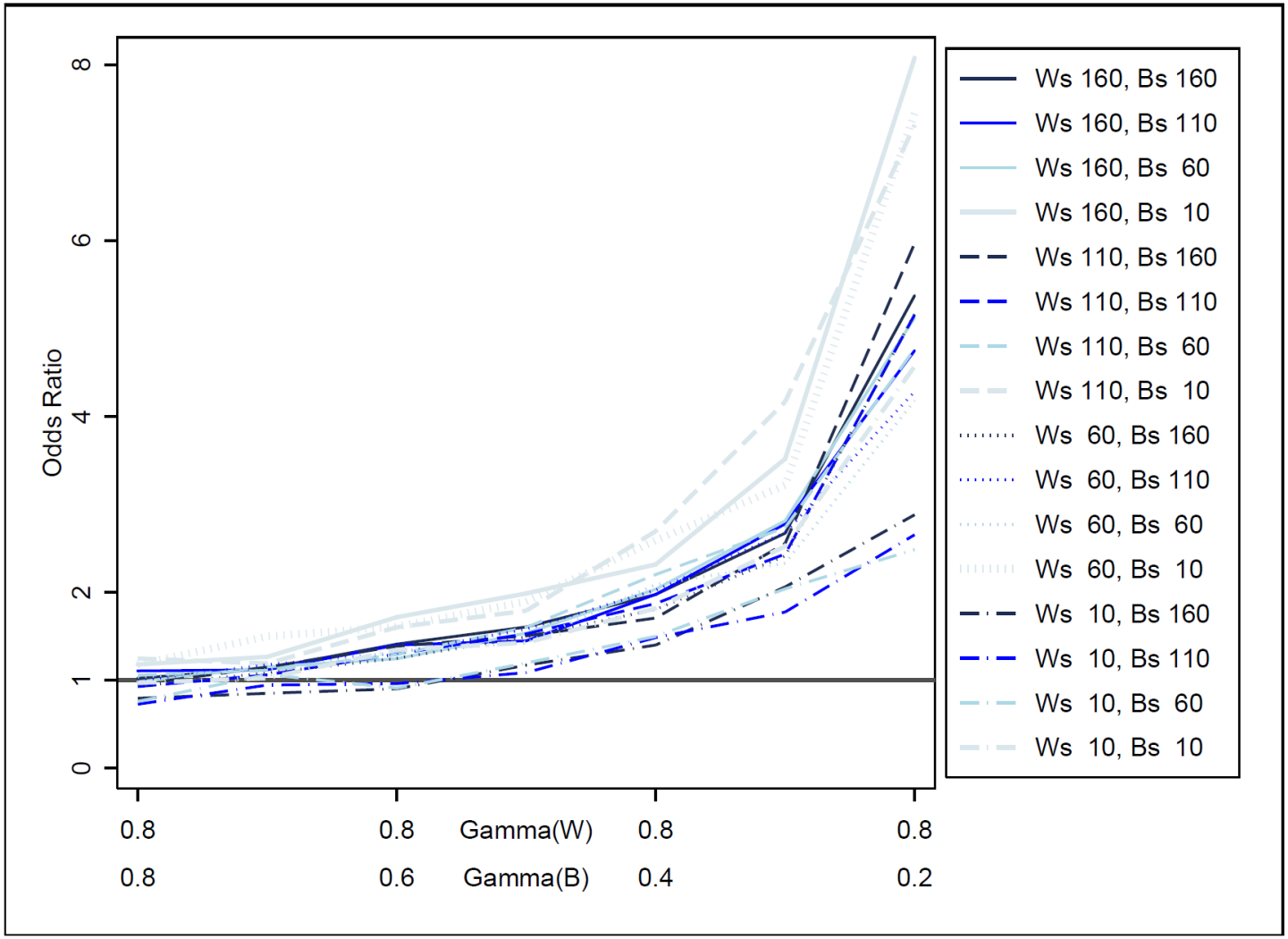
Odds Ration > 1
advantage for majority group/ group with higher gamma

Odds Ration < 1
advantage for minority group/ group with lower gamma

Figure 4: "Perfect" Labor Market Conditions and "Reduced Mobility"



Summary & Conclusions

1. Phelp‘s measurement model of statistical discrimination explains inequality in hiring.
   - The direction of discrimination mainly depends on the ratio of open positions to applicants,
   - and partly on the relative size of the minority group (not shown).

2. For access to qualified positions, the mechanism will always result in discrimination against the minority group.
   - More pronounced when minority group is smaller (not shown)

3. Reduced mobility substantially pronounces these effects.

→ As inequality is mainly attributed to allocation, not to within-job wage differentials, inequality research should take statistical discrimination into account.

→ But is it reasonable to stick with Phelp’s formula ?

Thank you!

Method: Simulation using Stata

- **Use Stata data matrix to store …**
  - employers and their parameters in columns;
  - applicants (signals and group W_{hites}, B_{lacks}) in lines
- **Use some random function to** (standard normal Gaussian)
  - assign productivity signals (mean=50, std=10) to applicants (L_1 … L_n)
  - assign them group membership afterwards
  - assign who does apply with which employer ("x")
- **Set for employers**
  - same average productivity
  - some meaningful variation in reliabilities γ

Table 2: Example Matrix of Data Setup

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				E_1	E_2	…	E_j	…	E_m
			α_W	50	50	…	50	…	50
			α_B	50	50	…	50	…	50
			γ_W	0.8	0.8	…	0.8	…	0.8
			γ_B	0.6	0.6	…	0.6	…	0.6
	Signal	Group							
L_1	50	W		x			x		
L_2	45	B			x				
…	…	…							
L_i	55	B		x					
…	…	…							x
L_n	50	W					x		

Simulation Model: Descriptives of the 260 runs in Figure 1 [Backup]

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	Mean	Std. Dev.	Min.	Max.
A: Parameter Settings				
E - Number of Employers	100.0	0	100.0	100.0
γ_W	0.8	0.000	0.8	0.8
γ_B	0.5	0.187	0.2	0.8
L - Number of Workers	500.0	0	500.0	500.0
Share of B Workers	50.0	0	50.0	50.0
Number of Applications Ws	10.0	0	10.0	10.0
Number of Applications Bs	10.0	0	10.0	10.0
B: Simulated Values				
All Workers: Mean Signal	49.991	0.430	48.704	51.478
W Workers: Mean Signal	50.014	0.641	48.445	51.994
B Workers: Mean Signal	49.967	0.641	48.212	51.774
All Workers: Std. Dev. Signal	9.986	0.318	8.963	10.771
W Workers: Std. Dev. Signal	9.984	0.441	8.923	11.026
B Workers: Std. Dev. Signal	9.976	0.421	8.504	11.201

Higher threshold causes more inequality [Backup]

- In plots it is hard to see that higher threshold, causes more discrimination against Bs
- Here Odds-Ratios (show effects, regardless of absolute shares of hired workers)

Table 4: Simulation of Access to Qualified Positions

		Number of Employers and Threshold														
		—50—			—150—			—250—			—350—			—450—		
γ_W	γ_B	53		56	53		56	53		56	53		56	53		56
.8	.5	5.17	$<$	6.58	1.51	$<$	2.41	1.44	$<$	2.56	1.82	$<$	2.20	1.60	$<$	2.31
.8	.55	4.64	$>$	3.09	1.48	$<$	2.08	1.22	$<$	2.00	1.43	$<$	2.15	1.29	$<$	1.89
.8	.6	2.60	$<$	3.05	1.43	$<$	1.75	1.32	$<$	1.56	1.18	$<$	1.93	1.34	$<$	1.63
.8	.65	2.05	$>$	1.66	1.25	$<$	1.67	1.26	$<$	1.47	1.25	$<$	1.39	1.23	$<$	1.51
.8	.7	1.39	$<$	1.78	1.30	$>$	1.23	1.03	$<$	1.31	1.14	$<$	1.30	1.09	$<$	1.27
.8	.75	1.37	$=$	1.37	1.06	$<$	1.18	1.02	$<$	1.11	1.03	$<$	1.07	1.06	$<$	1.23
.8	.8	1.20	$>$	1.16	1.12	$>$	1.10	0.97	$<$	1.06	1.03	$<$	1.09	0.95	$<$	1.21

BACKUP

OLS-Regression of Share of B-Workers employed

VARIABLES	(1) Model_1	(2) Model_2
γ_W - γ_B	-0.233***	-0.230***
	(0.007)	(0.004)
W Workers: Mean Signal		-0.014***
		(0.001)
B Workers: Mean Signal		0.016***
		(0.001)
W Workers: Std. Dev. Signal		-0.011***
		(0.002)
B Workers: Std. Dev. Signal		0.009***
		(0.002)
Constant	0.209***	0.115
	(0.002)	(0.094)
Observations	260	260
R^2	0.826	0.932

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[BACKUP]

OLS-Regression of Share of W-Workers employed

VARIABLES	(1) Model_1	(2) Model_2
γ_W - γ_B	0.238***	0.235***
	(0.007)	(0.004)
W Workers: Mean Signal		0.014***
		(0.001)
B Workers: Mean Signal		-0.016***
		(0.001)
W Workers: Std. Dev. Signal		0.012***
		(0.002)
B Workers: Std. Dev. Signal		-0.008***
		(0.002)
Constant	0.190***	0.243**
	(0.002)	(0.096)
Observations	260	260
R^2	0.833	0.931

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

MAS-Simulations [Backup]

- **Multi-Agent-System (MAS)**

Reality *Makro 1*
- Population
- Labor Market
- Migration
- …

Simulation Model
- Agents
- Environment
- …

Theory
- Human Capital Th.
- Statistical Discr.
- …

?

Reality *Makro 2*
- Population
- Labor Market
- Inequality (?)

Reality vs. Simulation

How good is theory?
(How good is programming)

"Final State"
- E.g. estimated level of inequality