

Discrimination in Two-sided Matching Market:  
Experimental and Theoretical Evidence in Entrepreneurial Finance

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ABFER, 2024

# Motivation: Discrimination in Two-sided Matching Market

Studying discrimination in two-sided matching processes is crucial.

(labor market, college admissions, housing rentals market...)

**This paper:** explore the distinct features of discrimination and explains how it emerges endogenously in a two-sided matching context.

Focus on the VC-startup context

- abundant anecdotal evidence suggests gender discrimination exists on both sides
- persistent gender participation gap in high-growth entrepreneurship ▶ Trend
- a two-sided matching market, both sides have significant bargaining power

Literature: VC-side gender discrimination is well studied (i.e., the capital supply side)

This paper: focus on startup-side gender discrimination (i.e., the capital demand side)

# What We Do: Experiment + Theory

**(Experimental Part)** Implement an Incentivized Resume Rating (IRR) experiment with real US startup founders

- Identify the existence of gender discrimination, mechanisms, special features
- Provides empirical micro-foundations for the theoretical framework

**(Theoretical model)** Extends [Che, Kim and Zhong \(2020\)](#) into a matching market

- Explains under which conditions statistical discrimination arises in a two-sided matching market
- Explain the persistent gender gap and “glass ceiling”
- Information-related discrimination theory

# What We Find: Experiment + Theory

## (Experimental Part)

- Belief-driven gender discrimination exists; (profitability, [informativeness](#))
- Homophily exists within gender
- “Glass ceiling”: discrimination is more severe for high-quality female investors

## (Theoretical Part)

- With homophily and under-representation of a group
  - ▶ statistical discrimination arises
  - ▶ gender participation gap would persist
- Under certain conditions, male founder mainly discriminates against highly rated female investors (explains “glass ceiling”)

- **Discrimination Literature:**

Empirical: [informativeness](#), glass ceiling, homophily (capital demand side)

Theoretical: two-sided information-based discrimination theory

— Belief formation is endogenous

— Explain the discrimination generation process and its special features

[Craig and Fryer \(2017\)](#); [Che, Kim, and Zhong \(2020\)](#), etc.

- **Entrepreneurial Finance Literature:** explain female VCs' lower performance through capital demand side

[Gompers, Mukharlyamov, Weisburst and Xuan \(2014\)](#), [Croson and Gneezy \(2009\)](#), etc.

- **Gender Literature** explain gender gap in high-impact entrepreneurship

[Gompers et al. \(2014\)](#), [Bertrand, Goldin, and Katz \(2010\)](#), [Bertrand and Hallock \(2001\)](#), [Chetty, Hendren, Jones and Porter \(2020\)](#), etc.

- 1 Experimental Design
- 2 Results
- 3 Theory
- 4 Appendix

- **(Investor Databases)** global venture capitalists' individual-level demographic and contact information
  - a. Purchased commercial data:
    - ▶ Pitchbook
    - ▶ Crunchbase
  - b. Manually supplementing investors' demographics:
    - ▶ Rocketreach
    - ▶ Zoominfo
    - ▶ LinkedIn
    - ▶ Websites
- **(Experimental Data)** Ratings of randomized investor profiles

# Background Information of Participating Founders

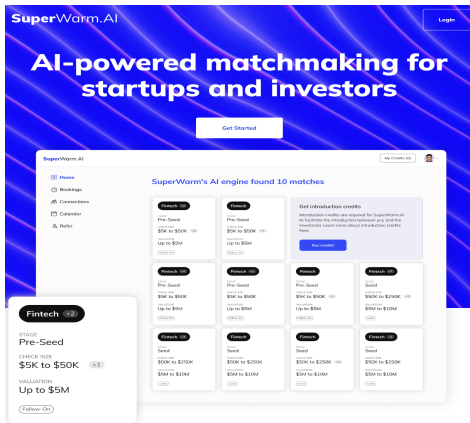
	N	Fraction (%)	Fraction (%) Crunchbase
<i>Panel A: Founder-level Stated Background Information</i>			
Female Founder	28	19.86%	15.27%
Minority Founder	37	26.24%	37.32%
Serial Founder	88	62.41%	N/A
Democratic Founder (Only for Wave 2)	27	28.12%	N/A
<i>Panel B: Startup-level Background Information</i>			
<i>Distribution of Sectors</i>			
Information technology	68	48.23%	43.94%
Consumers	28	19.86%	15.33%
Healthcare	19	13.48%	14.33%
Clean technology	2	1.42%	2.63%
Finance	12	8.51%	11.54%
Media	6	4.26%	16.26%
Energy	2	1.42%	2.35%
Education	3	2.13%	6.25%
Life sciences	5	3.55%	4.62%
Transportation & Logistics	6	4.26%	4.19%
Manufacture & Construction	10	7.09%	5.15%

- Recruitment: In total, 141 founders providing 2,820 valuations



# Experimental Design:

- **(Profile Evaluation)**  
evaluate 20 hypothetical randomized VC profiles  
(exogenous, no deception),  
to receive real matched VCs' information (incentive)
- **Experimental Setting:**  
Provides real investor recommendation services



# Experimental Design: Investor Profiles

**1. Jeffery Allen**  
(Angel Investor)

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**Background Information:**

- Angel Investor
- Fund Size (relatively small): \$5.07M
- Investment Philosophy: besides financial gains, also consider positive environmental and social impact, and commit to responsible investment.

**Entrepreneurial Experience:**

- Yes. Before becoming an investor, Jeffery Allen was also a innovation-focused entrepreneur. They were dedicated to introducing new levels of innovation and customer value to the global capital markets community.

**Investment Experience:**

- Years of experience: 5

**Education:**  
BA, Morehouse College

Notes:

AUM: assets under management, Dry Powder: available cash for new investments

Successful exits means that either the startup is acquired by a large firm or went to IPO.



Dynamically and **orthogonally** randomized VC characteristics

**Realistic** profiles: description, format, distribution

- **Mechanism Questions - (Belief Driven Mechanisms)**

- Q1. Quality evaluation (help you generate higher financial returns?)

- Q2. Availability evaluation (likelihood would invest in you?)

- Q5. **Informativeness** evaluation (how informative is the profile to you?)

- **Decision Questions**

- Q4. Contact decision (likelihood of contacting this investor?)

- Q3. Funding decision (How much money are you comfortable asking?)

# Result 1: Belief-Driven Gender Discrimination

Dependent Variable	Q1 Quality (1)	Q2 Availability (2)	Q5 Informativeness (3)	Q3 Funding (4)	Q4 Contact (5)
Female Investor	-3.17*** (0.82)	-3.20*** (0.75)	-5.25*** (0.91)	-0.17 (0.62)	-3.46*** (0.93)
Asian Investor	-0.98 (0.77)	-0.71 (0.64)	0.40 (0.60)	-0.11 (0.54)	-0.14 (0.70)
Very Selective School	1.74* (0.94)	1.18 (0.86)	0.31 (0.72)	-0.00 (0.65)	1.15 (0.97)
Graduate Degree	0.85 (0.94)	-0.20 (0.92)	-0.16 (0.73)	0.30 (0.74)	1.02 (0.97)
Senior Investor	8.11*** (1.55)	3.82** (1.30)	1.69 (1.11)	0.82 (1.04)	7.42*** (1.64)
Angel Investor	4.82*** (1.26)	3.41** (1.10)	1.71* (0.92)	-2.79** (0.95)	4.11** (1.38)
Large Fund	7.57*** (1.13)	4.35*** (1.08)	1.64** (0.81)	7.07*** (1.13)	7.65*** (1.26)
Entrepreneurial Experience	8.49*** (0.99)	4.86*** (0.77)	1.66** (0.61)	0.21 (0.65)	7.30*** (0.93)
ESG Fund	-1.67* (0.86)	-2.26** (0.96)	0.24 (0.53)	0.50 (0.65)	-2.10** (0.94)
Years of Investment Experiences	0.35*** (0.06)	0.22*** (0.05)	0.16*** (0.05)	0.11** (0.05)	0.35*** (0.06)
Subject FE	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variables	59.09	54.95	67.36	48.71	60.15
Observations	2820	2820	2820	2820	2820
R-squared	0.504	0.583	0.669	0.698	0.531

- 3.46% lower p.p. lower contact interest ratings to female VCs
- Low perception on women's quality, availability, and informativeness

## Result 2: Gender Homophily

Dependent Variable	Q1 Quality (1)	Q2 Availability (2)	Q5 Informativeness (3)	Q3 Funding (4)	Q4 Contact (5)
Female Investor	-4.39*** (0.96)	-4.08*** (0.82)	-6.52*** (1.03)	-0.59 (0.69)	-4.84*** (1.05)
Female Investor × Female Founder	5.24** (2.26)	3.63* (2.00)	5.89** (2.12)	1.70 (1.56)	5.97** (2.27)
Female Founder	-1.72 (1.44)	-43.04*** (1.28)	11.74*** (1.33)	-38.79*** (0.99)	-35.43*** (1.44)
Asian Investor	-1.57* (0.94)	-1.37* (0.71)	0.11 (0.71)	-0.42 (0.61)	-0.86 (0.86)
Asian Investor × Asian Founder	2.28 (2.47)	3.22* (1.93)	1.13 (1.33)	1.91 (1.21)	3.29 (2.11)
Asian Founder	-7.42*** (1.33)	29.82*** (1.14)	-21.85*** (0.92)	27.67*** (0.80)	26.64*** (1.20)
Subject FE	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variables	59.09	54.95	67.36	48.71	60.15
Observations	2820	2820	2820	2820	2820
R-squared	0.388	0.547	0.660	0.674	0.444

- Male founders drive gender discrimination against female VCs
- “Female Investor × Female Founder” is equal to 5.97 p.p. increase

## Result 3: Glass Ceiling (High-quality VCs More Affect)

Dependent Variable	Q1 Quality (1)	Q2 Availability (2)	Q5 Informativeness (3)	Q3 Funding (4)	Q4 Contact (5)
Female Investor	2.19 (1.61)	0.14 (1.26)	-4.56** (1.47)	0.52 (0.92)	2.53* (1.51)
Female Investor × High-Quality Investor	-5.73** (1.90)	-3.33** (1.62)	-0.11 (1.41)	-0.42 (1.32)	-6.24** (1.90)
Asian Investor	-1.50 (1.63)	0.20 (1.27)	2.25** (1.10)	0.50 (0.89)	-0.03 (1.47)
Asian Investor × High-Quality Investor	0.49 (1.82)	-1.49 (1.51)	-2.81** (1.25)	-0.87 (1.20)	-0.38 (1.74)
High-Quality Investor	30.87*** (2.20)	24.22*** (1.95)	13.02*** (1.55)	9.22*** (1.48)	36.95*** (2.29)
Subject FE	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variables	59.09	54.95	67.36	48.71	60.15
Observations	2820	2820	2820	2820	2820
R-squared	0.570	0.651	0.695	0.690	0.663

### Method I (OLS):

- Quality is predicted by other orthogonally randomized characteristics.
- Mainly discriminate against high-Quality female VCs

## Result 4: Glass Ceiling (High-quality VCs More Affect)

Dependent Variable: Contact Interest Ratings

	5th [1]	15th [2]	25th [3]	35th [4]	45th [5]	55th [6]	65th [7]	75th [8]	85th [9]	95th [10]
Female Investor	8.17** (3.61)	-0.35 (1.77)	-2.94** (1.48)	-3.84*** (1.08)	-2.71*** (0.96)	-1.94** (0.89)	-2.75** (1.13)	-3.38*** (1.15)	-4.76*** (1.44)	-3.35*** (1.21)
Asian Investor	0.87 (2.38)	0.19 (1.44)	0.77 (1.20)	0.74 (0.86)	0.06 (0.57)	-0.47 (0.62)	-0.60 (0.84)	-0.42 (0.84)	-0.56 (0.99)	-0.23 (0.88)
Leave-one-out Median of $Q_4$ Ratings	0.39*** (0.08)	0.71*** (0.06)	0.89*** (0.04)	0.95*** (0.03)	0.97*** (0.01)	0.96*** (0.02)	0.85*** (0.04)	0.72*** (0.04)	0.56*** (0.05)	0.26*** (0.06)
Quantile of Dep. Var.	6	29	44	51	60	66	74	82	90	100
Observations	2,820	2,820	2,820	2,820	2,820	2,820	2,820	2,820	2,820	2,820
R-squared	0.24	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.33

### Method II (Quantile regression):

- Control for founders' rating levels
- Mainly discriminate against high-quality female VCs (measured by received contact interest ratings)

## Result 5: Implicit Gender Discrimination

Dependent Variable	Response Time (Unit: Second) (1)	Q1 Quality (2)	Q2 Availability (3)	Q5 Informativeness (4)	Q3 Funding (5)	Q4 Contact (6)
Second Half of Study	-21.96*** (1.34)	4.49** (1.44)	3.88** (1.28)	2.76** (0.95)	-0.97 (1.00)	3.45** (1.47)
Female Investor	-0.19 (1.12)	-0.02 (1.13)	-0.87 (0.99)	-3.94*** (0.96)	0.24 (0.82)	-1.51 (1.20)
Female Investor × Second Half of Study		-6.51*** (1.54)	-4.88*** (1.44)	-2.65** (1.04)	-0.98 (1.25)	-4.15** (1.67)
Asian Investor	2.67** (1.20)	-0.26 (1.07)	-0.05 (0.89)	0.80 (0.83)	-0.54 (0.71)	0.05 (1.12)
Asian Investor × Second Half of Study		-1.80 (1.57)	-1.59 (1.32)	-1.03 (1.11)	0.93 (1.14)	-0.80 (1.61)
p-value of Female Investor in the second half of study		0.00	0.00	0.00	0.47	0.00
p-value of Asian Investor in the second half of study		0.26	0.19	0.91	0.29	0.65
Subject FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variables	43.82	59.09	54.95	67.36	48.71	60.15
Observations	2820	2820	2820	2820	2820	2820
R-squared	0.40	0.39	0.55	0.66	0.67	0.44

- Founders spent 21.96 seconds less evaluating profiles in the 2nd half of the study
- The detected discrimination mostly arises in that portion



## What can the model explain?

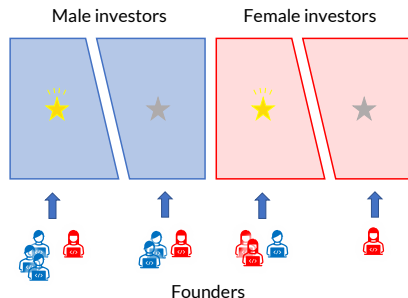
- How statistical discrimination is generated **endogenously** in a matching market
- Glass ceiling (mainly discriminate against high-quality minority candidates)
- Persistent gender participation gap (women participation rate is constantly low)

## Key Elements of the model

- Information story (information quantity)
- Homophily
- Underrepresentation of the minority group

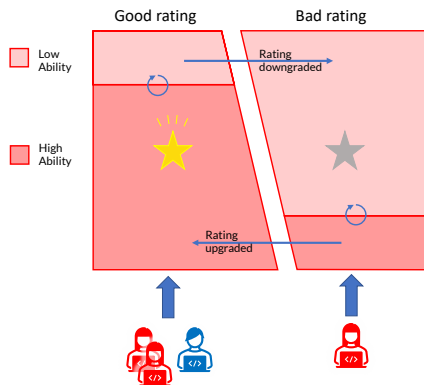
# Theory of two-sided statistical discrimination

- Founders search for VCs based on
  - ▶ **Ratings** ( $j = G, B$ ) informative about ability ;
  - ▶ **Identities** ( $\ell, r = M, F$ ) unrelated to ability.
- Matches created at rate  $P_{j,\ell}^k Q_{j,\ell}^{1-k}$ .
  - ▶  $P_{j,\ell}$ : mass of founders;
  - ▶  $Q_{j,\ell}$ : mass of investors,  $Q_M > Q_F$ .
  - ▶  $\phi_{j,\ell}, \psi_{j,\ell}$ : per investor/founder matching rate.
- Discrimination:
  - ▶ Evaluators treat different identities differently due to beliefs (statistical discrimination).



# Theory of two-sided statistical discrimination

- Ratings and ability:
  - ▶ Unobserved ability  $i = H, L$ .
  - ▶  $H \leftrightarrow L$  with rate  $\delta$ .
  - ▶ Ratings “corrected” at rate  $\alpha$  conditional on matching.
  - ▶ Let  $\mu_{lj}$  denote the posterior belief of  $H$  in market  $lj$ .
- Features of the model:
  - ▶ The intrinsic ability of male and female VCs has identical distribution.
  - ▶ Fully rational belief formation and search behavior.



# Theory of two-sided statistical discrimination

- Founder-side discrimination:

- ▶ Founder utility from searching in market  $\ell j$ :  
 $(\phi_{\ell j} - \kappa \cdot \chi_{\ell \neq r})(u_H \mu_{\ell j} + u_L(1 - \mu_{\ell j}) - \rho)$
- ▶ Positive  $\kappa$  means homophily.

- Equilibrium notion:

- ▶  $P_{\ell, i, j}, Q_{\ell, j}^r$  (mass of founders and investor) all stationary.
- ▶ Founder indifferent between searching all markets.
- ▶ An equilibrium is discriminatory if  $\mu_M \neq \mu_F$ .  
(posterior belief is different for  $M$  and  $F$ )

# Theory of two-sided statistical discrimination

- Predictions under **one-sided** discrimination [Che, Kim, and Zhong \(2020\)](#):
  - ▶ When evaluators (i.e., founders) are non-discriminatory,
    - ★ Mechanically, all equilibria are non-discriminatory.
  - ▶ When startups are non-discriminatory,
    - ★  $\kappa = 0$ . Let  $\beta = \alpha/\delta$  (rating quality), then:

## Proposition

*Fixing  $k > \underline{k}$  and  $Q > 0$ , there exists  $(\underline{\beta}, \bar{\beta})$  s.t. a (stable) discriminatory equilibrium exists if and only if  $\beta \in (\underline{\beta}, \bar{\beta})$ .*

- ★ Discrimination created by informational externality, diminishes eventually with technological progress.

# Theory of two-sided statistical discrimination

- Predictions under **two-sided** discrimination:
  - ▶ Investors can adopt discriminatory search strategy, and  $\kappa > 0$ .

## Proposition

*There exists a unique discriminatory equilibrium. There exists  $q$  s.t.*

*when  $\frac{Q_M}{Q_F} < q$ ,*

- ★ *female investors match with female founders;*
- ★ *male investors match with male founders and female founders with B ratings.*

*when  $\frac{Q_M}{Q_F} > q$ ,*

- ★ *female investors match with female founders with G ratings;*
- ★ *male investors match with all founders.*

- ▶ Key argument:

- ★ Suppose

$$(\phi_{\ell G})(u_H \mu_{\ell G} + u_L(1 - \mu_{\ell G}) - p) = (\phi_{\ell B})(u_H \mu_{\ell B} + u_L(1 - \mu_{\ell B}) - p),$$

$\implies$

$$(\phi_{\ell G} - \kappa)(u_H \mu_{\ell G} + u_L(1 - \mu_{\ell G}) - p) < (\phi_{\ell B} - \kappa)(u_H \mu_{\ell B} + u_L(1 - \mu_{\ell B}) - p).$$

- ★ Homophily exaggerated on high ability founders.

## Conclusion:

**This paper:** explore the distinct features of discrimination in a two-sided matching market and how it emerges.

(focus on the VC-startup context)

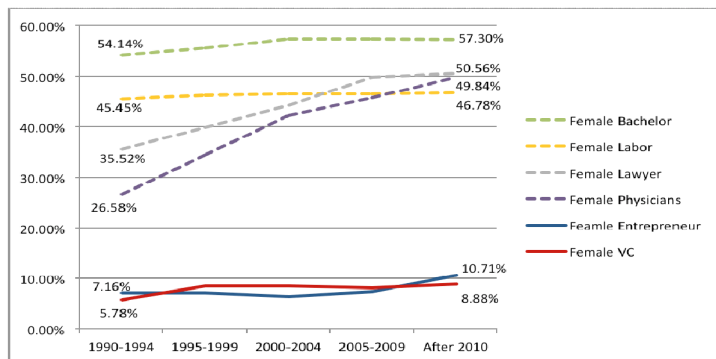
**Experiment:** startup founders discriminate against female VCs

- Belief-driven discrimination: profitability, informativeness
- Gender homophily exists
- Glass ceiling

**Theory (Information Story):** with homophily and under-representation of the minority group in a two-sided matching market, we will observe:

- Statistical discrimination
- Glass ceiling
- Persistent gender gap in market participation

# Gender Gaps in Different Fields



Source: "Diversity in Innovation" Gompers and Wang (2019)




# Experimental Design: Interface

1. What's the probability that you feel Jonathan Rogers can help your company generate higher financial returns based on his quality? (Think only about your perception of his quality and attractiveness when gauging your interest level in the investor—imagine that he is guaranteed to finance your startup.)

Not interested 0 10 20 30 40 50 60 70 80 90 100 **Want to collaborate for sure**


Probability of collaboration (Click on the bar)



2. What's the probability that you think Jonathan Rogers would show interest (e.g., offer a meeting or further discussions) in providing funding for your startup? (Think only about whether you feel he would finance you or not—when gauging how likely he would be to finance your startup, imagine that he has many startups to choose from.)

Will not show interest 0 10 20 30 40 50 60 70 80 90 100 **Show interest for sure**

Probability of showing interest




3. How much money are you comfortable asking for from Jonathan Rogers compared to your original funding plan, considering both his potential interest in your startup and your collaboration interest with him? (For example, if you feel it is safe to ask for 80% of your original planned funding needed from Jonathan Rogers, you can move the bar to 8.8.)

0 0.2 0.4 0.6 0.8 **Benchmark** 1.2 1.4 1.6 1.8 —2

100% 50 100


percentage



4. How likely would you be to contact Jonathan Rogers (e.g., send an email, build networks and relationships) for a meeting to discuss your startup financing, considering both his potential interest in your startup and your collaboration interest with him? (Remember that you have limited energy and the algorithm will generate top 10 recommended investors to you based on your preferences.)

Will not contact 0 10 20 30 40 50 60 70 80 90 100 **Contact for sure**


Probability of contact



5. Imagine that you have access to a professional online profile or resume of the investor. To what extent do you think the profile is informative for evaluating Jonathan Rogers as a prospective collaborator?

Not informative at all 0 10 20 30 40 50 60 70 80 90 100 **Provides all the information**

Informative



**Back** **Next**




Figure A5: Sample Evaluation Questions

# Result 5: Implicit Discrimination

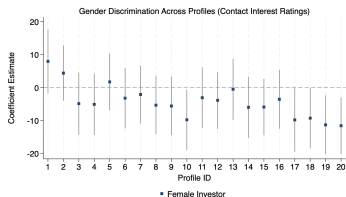


Figure B2: Gender Discrimination Across Profiles (Contact Interest Ratings)

*Notes.* This figure demonstrates how investors' gender affects recruited founders' contact interest ratings across profiles. It shows how founders' gender discrimination evolves as the study progresses to the end. The horizontal line describes the order of each investor profile displayed to the experimental subjects (i.e., the  $h^{\text{th}}$  displayed investor profile). The vertical line is the coefficient of "Female Investor" of the following regressions:  $Q_{4ij} = \alpha + \beta_1 \text{Female Investor}_{ij} + \beta_2 \text{Asian Investor}_{ij} + \epsilon_{ij}$  for all subjects' evaluation results of the  $h^{\text{th}}$  displayed investor profiles, with 95% confidence interval. This represents the magnitude of gender discrimination as measured by startup founders' contact interest ratings (i.e.,  $Q_4$ ).

▶ Back1

▶ Back2

# Response Time Evolution

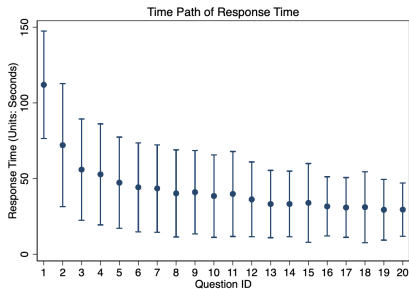


Figure B1: Time Path of Response Time

*Notes.* This figure demonstrates the time-path of startup founders' response time as the study progresses to the end. The x-axis is the profile ID, which indicates the order of profiles displayed to each startup founder. The y-axis reports the mean and standard deviation of startup founders' response time measured in seconds.

▶ Back1

▶ Back2