# Online Appendix for "Statistical Discrimination and Affirmative Action in the Lab"

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**Abstract**

We first reproduce the main results of the paper using data from only the last five rounds of each stage. We illustrate that results remain qualitatively similar. We then present evidence that participants' beliefs are, with a few important exceptions, well-calibrated with their opponents' actions. We also provide evidence that the results are not primarily driven by one side of the market: rather, both workers and firms exhibit simultaneous and similar responses to changes in game parameters. We include various robustness regression analyses. Finally, we conduct a counterfactual exercise to investigate firms' hiring decisions when faced with a menu that includes both types of workers.

# 1 Learning within Stages

One may worry that the first few rounds of each stage are tainted by participants' attempts to learn various features of the relevant game. Tables 1 - 4 reproduce Tables 3 - 6 presented in the paper using data from the last five rounds of each stage. As can be readily seen, results resemble those reported in the body of the paper.

| | Seed Stage | | | | | |
|---|---|---|---|---|---|---|
| Treatment | Investment | | | Hiring | | |
| | GREEN | | PURPLE | GREEN | | PURPLE |
| Subsidy | 0.90 | $>^{***}$ | 0.01 | 0.93 | $>^{***}$ | 0.09 |
| High Subsidy | 0.95 | $>^{***}$ | 0.10 | 0.91 | $>^{***}$ | 0.06 |
| Long Subsidy | 0.88 | $>^{***}$ | 0.00 | 0.85 | $>^{***}$ | 0.05 |

Table 1: Investment/hiring decisions in the seed stage (unequal investment costs)
Data from the last five rounds of the stage
Significance levels are indicated as follows: *** $p < 0.01$

| | Baseline Stage | | | | | |
|---|---|---|---|---|---|---|
| Treatment | Investment | | | Hiring | | |
| | GREEN | | PURPLE | GREEN | | PURPLE |
| Subsidy | 0.83 | $>^{***}$ | 0.43 | 0.85 | $>^{***}$ | 0.44 |
| High Subsidy | 0.90 | $>^{***}$ | 0.47 | 0.87 | $>^{***}$ | 0.49 |
| Long Subsidy | 0.82 | $>$ | 0.72 | 0.82 | $>^{***}$ | 0.61 |

Table 2: Investment/hiring decisions in the baseline stage (equal investment costs)
Data from the last five rounds of the stage
Significance levels are indicated as follows: *** $p < 0.01$

| Treatment | Introducing AA | | | | | |
|---|---|---|---|---|---|---|
| | Investment | | | Hiring | | |
| | GREEN | | PURPLE | GREEN | | PURPLE |
| Subsidy | 0.77 | $>$ | 0.65 | 0.67 | $>$ | 0.65 |
| High Subsidy | 0.76 | $>$ | 0.68 | 0.70 | $<^{***}$ | 0.90 |
| Long Subsidy | 0.72 | $<^{**}$ | 0.88 | 0.60 | $<^{***}$ | 0.86 |

Table 3: Investment/hiring decisions during affirmative action
Data from the last five rounds of the stage
Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$

| Treatment | Removing AA | | | | | |
|---|---|---|---|---|---|---|
| | Investment | | | Hiring | | |
| | GREEN | | PURPLE | GREEN | | PURPLE |
| Subsidy | 0.79 | $>^{***}$ | 0.39 | 0.64 | $>^{***}$ | 0.31 |
| High Subsidy | 0.82 | $>^{**}$ | 0.52 | 0.77 | $>^{***}$ | 0.47 |
| Long Subsidy | 0.78 | $>$ | 0.63 | 0.70 | $>$ | 0.60 |

Table 4: Investment/hiring decisions after affirmative action
Data from the last five rounds of the stage
Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$

# 2 Are Participants' Beliefs Correct?

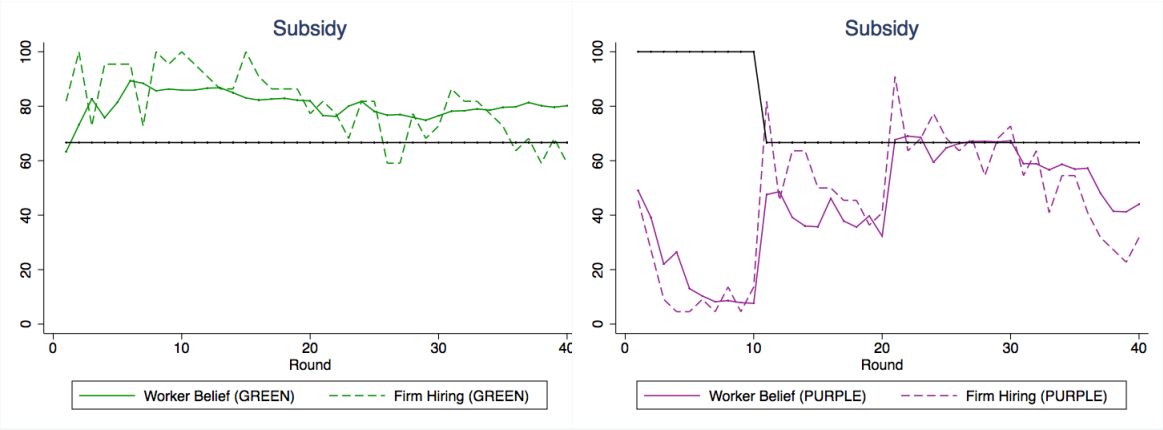


Figure 1: Workers' beliefs and firms' hiring decisions in the Subsidy treatment


Figure 2: Workers' beliefs and firms' hiring decisions in the High Subsidy treatment

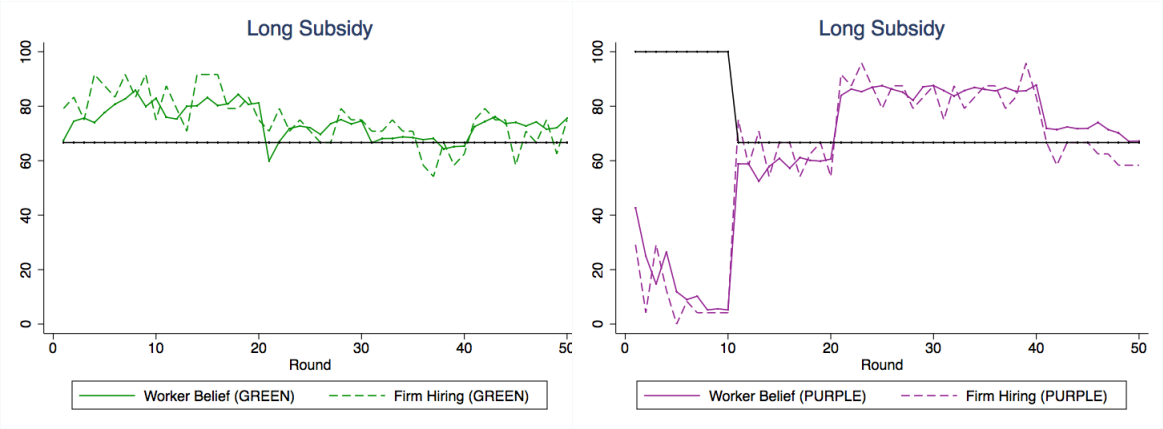


Figure 3: Workers' beliefs and firms' hiring decisions in the Long Subsidy treatment

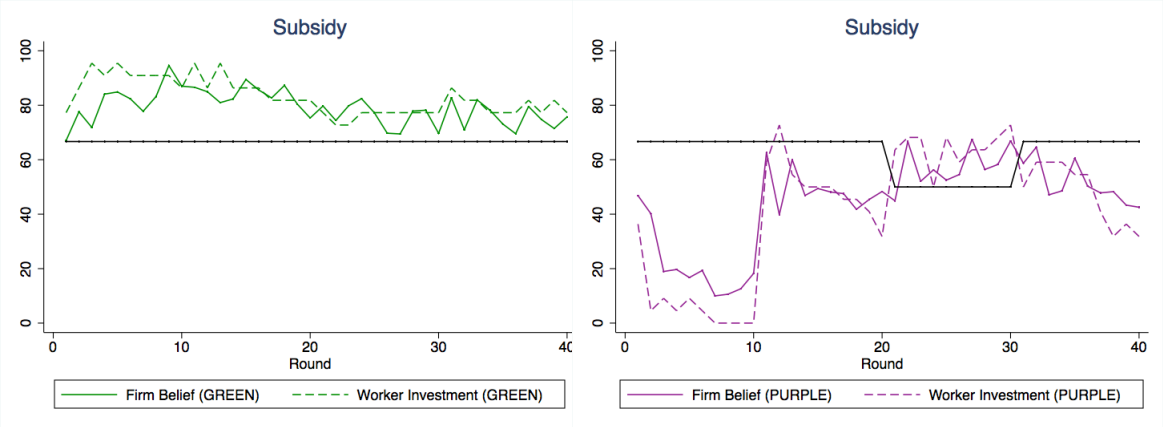


Figure 4: Firms' beliefs and workers' investment decisions in the Subsidy treatment

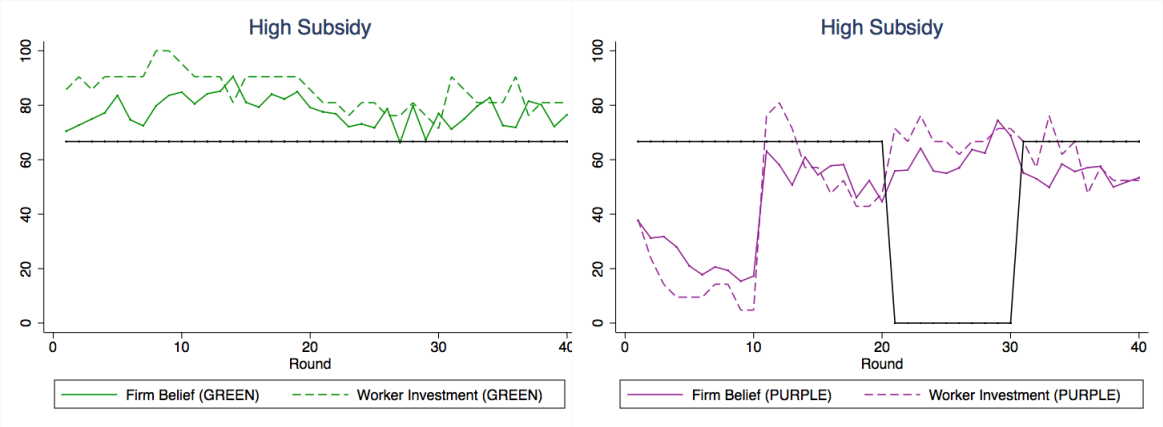


Figure 5: Firms' beliefs and workers' investment decisions in the High Subsidy treatment

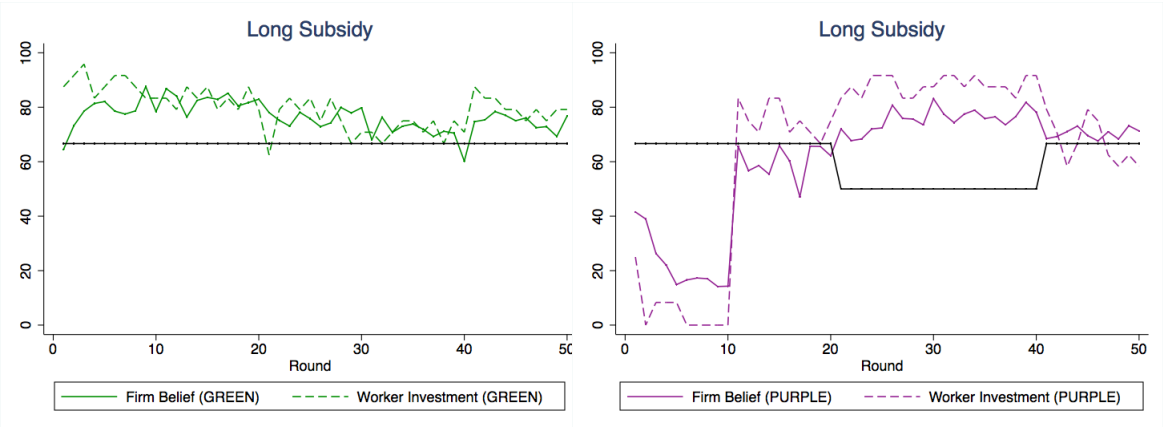


Figure 6: Firms' beliefs and workers' investment decisions in the Long Subsidy treatment

In general, participants hold fairly well-calibrated beliefs that track rather closely observed behavior. GREEN workers and firms facing them are somewhat excessively pessimistic at the very beginning. Nonetheless, their beliefs throughout are sufficiently optimistic to justify investment and hiring. When turning to PURPLE workers and the firms they are paired with, we see that both workers and firms are somewhat overly optimistic in the first, seeding stage. They are overly pessimistic when affirmative action is introduced, and then overly optimistic when it is lifted. Nonetheless, these deviations do not affect best responses, and are therefore consistent with the high rates of best responses reported in the main text.

# 3 Which Side is Driving Results?

It is conceivable that the responses we see in the experiment are primarily driven by one side of the market. For instance, one may wonder whether when affirmative action is removed, PURPLE workers initially continue to invest, giving firms the benefit of the doubt, even though firms immediately cut back on their hiring of PURPLE workers. After experiencing the lower hiring rates, PURPLE workers would then respond, with a time lag, by reducing their investment rates. To investigate whether these types of narratives have empirical content, we look at the average investment and hiring rates of PURPLE workers in the two rounds before and after each stage transition. As Table 5 shows, both PURPLE workers and the firms paired with them respond simultaneously and similarly to changes in stage parameters across our treatments. This suggests that neither side of the market is uniquely responsible for either the emergence or the breakdown of efficient coordination.

| | Subsidy | | High Subsidy | | Long Subsidy | |
|---|---|---|---|---|---|---|
| | Investment | Hiring | Investment | Hiring | Investment | Hiring |
| Round 9 | 0.00 | 0.05 | 0.05 | 0.05 | 0.00 | 0.04 |
| Round 10 | 0.00 | 0.14 | 0.05 | 0.14 | 0.00 | 0.04 |
| BASELINE (EQUAL COSTS) | | | | | | |
| Round 11 | 0.59 | 0.82 | 0.76 | 0.71 | 0.83 | 0.75 |
| Round 12 | 0.73 | 0.45 | 0.81 | 0.67 | 0.75 | 0.58 |
| Round 19 | 0.41 | 0.36 | 0.43 | 0.52 | 0.67 | 0.67 |
| Round 20 | 0.32 | 0.41 | 0.48 | 0.33 | 0.75 | 0.54 |
| AFFIRMATIVE ACTION | | | | | | |
| Round 21 | 0.64 | 0.91 | 0.71 | 0.81 | 0.83 | 0.92 |
| Round 22 | 0.68 | 0.64 | 0.67 | 0.86 | 0.88 | 0.88 |
| Round 29/39 | 0.68 | 0.68 | 0.71 | 0.90 | 0.92 | 0.96 |
| Round 30/40 | 0.73 | 0.73 | 0.71 | 0.86 | 0.92 | 0.83 |
| REMOVAL OF AFFIRMATIVE ACTION | | | | | | |
| Round 31/41 | 0.50 | 0.55 | 0.67 | 0.67 | 0.79 | 0.67 |
| Round 32/42 | 0.59 | 0.64 | 0.57 | 0.71 | 0.71 | 0.58 |

Table 5: Behavior before and after stage transitions (PURPLE workers and paired firms).

# 4 Survey Responses and Risk Attitudes as Controls

As mentioned in the body of the paper, we elicited risk attitudes at the end of each session using two tasks of the form suggested by Gneezy and Potters (1997). Namely, participants had to allocate 200 tokens (translating to 2 dollars) between a safe project, which returned the amount of tokens invested for sure, and a risky project. In one task, the risky project returned 2.5 times the amount invested with 50% probability and 0 otherwise; in the second task, the risky project returned 3 times the amount invested with 40% probability and 0 otherwise. In addition, we had participants fill a survey containing various demographic questions.[1]

Tables 6 and 7 reproduce the regression analysis reported in Tables 15 and 16 in the paper, adding responses to the risk elicitations and survey as controls. Specifically, the control variables we use are constructed as follows:

- Female: dummy variable that equals 1 if the participant identifies her gender as "Female"
- Minority: dummy variable that equals 1 if the participant identifies her ethnicity as "Hispanic", "African American", or "Native American"[2]
- Right-Wing: dummy variable that equals 1 if the participant identifies her political views as "Moderate", "Conservative", or "Very Conservative"[3]
- Risk Task 1: the number of tokens the participant chooses to invest in the first risk task (from 0 to 200)
- Risk Task 2: the number of tokens the participant chooses to invest in the second risk task (from 0 to 200)

[1] Details of the survey are available at `http://www.leeatyariv.com/papers/Discrimination_Demographics.pdf`

[2] No participants identified as Native American in our experimental sessions.

[3] In the experiment, only 7% of participants identified as either "Conservative" or "Very Conservative". Constructing the variable in this fashion allows us to classify 34% of participants as "Right-Wing".

| VARIABLE: Firm Belief | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.086** | 0.067** | 0.145*** | |
| | (0.039) | (0.032) | (0.035) | |
| Removing AA | 0.031 | -0.003 | 0.098*** | 0.098*** |
| | (0.055) | (0.031) | (0.032) | (0.032) |
| Introducing AA (first half) | | | | 0.131*** |
| | | | | (0.038) |
| Introducing AA (second half) | | | | 0.159*** |
| | | | | (0.038) |
| Female | -0.064 | -0.015 | -0.116 | -0.116 |
| | (0.062) | (0.096) | (0.070) | (0.071) |
| Minority | -0.093 | -0.197** | -0.082 | -0.082 |
| | (0.068) | (0.092) | (0.077) | (0.077) |
| Right-Wing | -0.024 | -0.123 | 0.022 | 0.021 |
| | (0.069) | (0.081) | (0.071) | (0.071) |
| Risk Task 1 | 0.000 | -0.001 | -0.002 | -0.002 |
| | (0.000) | (0.002) | (0.001) | (0.001) |
| Risk Task 2 | 0.000 | 0.002 | 0.002 | 0.002 |
| | (0.000) | (0.001) | (0.001) | (0.001) |
| Constant | 0.502*** | 0.569*** | 0.721*** | 0.722*** |
| | (0.087) | (0.148) | (0.114) | (0.114) |
| Observations | 660 | 630 | 960 | 960 |
| Number of participants | 44 | 42 | 48 | 48 |

Table 6: Results from OLS regressions. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Hire | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.178*** | 0.331*** | 0.215*** | |
| | (0.064) | (0.054) | (0.052) | |
| Removing AA | -0.088 | -0.017 | -0.006 | -0.006 |
| | (0.076) | (0.053) | (0.054) | (0.054) |
| Introducing AA (first half) | | | | 0.228*** |
| | | | | (0.055) |
| Introducing AA (second half) | | | | 0.203*** |
| | | | | (0.055) |
| Female | -0.070 | -0.081 | -0.138 | -0.138 |
| | (0.089) | (0.136) | (0.088) | (0.088) |
| Minority | -0.041 | -0.218* | -0.093 | -0.093 |
| | (0.082) | (0.119) | (0.091) | (0.091) |
| Right-Wing | -0.015 | 0.009 | -0.012 | -0.012 |
| | (0.086) | (0.096) | (0.103) | (0.104) |
| Risk Task 1 | 0.000 | -0.003 | -0.002 | -0.002 |
| | (0.001) | (0.002) | (0.002) | (0.002) |
| Risk Task 2 | 0.001 | 0.003 | 0.002 | 0.002 |
| | (0.001) | (0.002) | (0.001) | (0.001) |
| Constant | 0.494*** | 0.630*** | 0.753*** | 0.753*** |
| | (0.121) | (0.179) | (0.149) | (0.148) |
| Observations | 660 | 630 | 960 | 960 |
| Number of participants | 44 | 42 | 48 | 48 |

Table 7: Results from OLS regressions. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

As apparent from these tables, even with the additional controls, coefficients on treatment dummies remain virtually identical to those reported in the paper. Furthermore, all but one control in one treatment (reflecting membership in a minority group) exhibit no significant effect on hiring decisions or reported beliefs. Given the number of controls and treatments, we suspect the significant effect we see for minority membership might be spurious.

# 5 Identifying Firm Types

One might suspect that firms' responses to affirmative action policies being introduced and removed depends on the extent to which they treat GREEN and PURPLE workers differently initially, in the baseline stage. In this section, we identify firm "types" according to their likelihood of hiring a PURPLE worker in the baseline stage. We then inspect firms' responses to affirmative action and its removal, in terms of hiring patterns and reported beliefs, for different types separately.

Specifically, we first calculate each firm's average hiring rate for GREEN workers in our baseline Stage 2 ($Stage2_G$) and average hiring rate for PURPLE workers in the baseline Stage 2 ($Stage2_P$). Using these values, we define a variable $Stage2_\Delta = Stage2_G - Stage2_P$ that captures each firm's level of discrimination. The types are then constructed as follows:

- Non-discriminatory: $Stage2_\Delta \leq 0$
- Low-discriminatory: $Stage2_\Delta \in (0, 0.50]$
- High-discriminatory: $Stage2_\Delta > 0.50$

Across all treatments, the 134 participants in firm roles are divided as follows: 40% are non-discriminatory, 29% are low-discriminatory, and 31% are high-discriminatory. Of the non-discriminatory firms, 87% have equal hiring rates between GREEN and PURPLE workers ($Stage2_\Delta = 0$) and 13% favor PURPLE workers in their hiring decisions ($Stage2_\Delta < 0$).

Tables 8 - 10 reproduce the regression analysis reported in Table 16 separately for different firm types, while Tables 11 - 13 reproduce the regression analysis reported in Table 15 separately for different firm types.

Unsurprisingly, we see little effect of affirmative action or its removal on actions or beliefs of non-discriminatory firms. The patterns for firms that are initially discriminatory are qualitatively in line with those reported in the paper: affirmative action alleviates discrimination, its removal brings the market close to its baseline prior to affirmative action, and beliefs are less responsive to affirmative action than hiring likelihoods. Furthermore, the Long Subsidy treatment is more effective in eroding some discriminatory tendencies. All these effects are more pronounced for highly discriminatory firms.

| VARIABLE: Hire | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | -0.121* | -0.011 | -0.017 | |
| | (0.067) | (0.034) | (0.041) | |
| Removing AA | -0.365*** | -0.030 | -0.167*** | -0.167*** |
| | (0.117) | (0.040) | (0.055) | (0.055) |
| Introducing AA (first half) | | | | -0.015 |
| | | | | (0.057) |
| Introducing AA (second half) | | | | -0.020 |
| | | | | (0.035) |
| Constant | 0.848*** | 0.915*** | 0.853*** | 0.853*** |
| | (0.088) | (0.084) | (0.067) | (0.067) |
| Observations | 243 | 214 | 444 | 444 |
| Number of participants | 17 | 14 | 23 | 23 |

Table 8: Results from OLS regressions for non-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Hire | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.170 | 0.376*** | 0.185** | |
| | (0.119) | (0.079) | (0.071) | |
| Removing AA | -0.155 | -0.013 | -0.031 | -0.031 |
| | (0.090) | (0.107) | (0.095) | (0.095) |
| Introducing AA (first half) | | | | 0.192*** |
| | | | | (0.050) |
| Introducing AA (second half) | | | | 0.178* |
| | | | | (0.094) |
| Constant | 0.567*** | 0.487*** | 0.646*** | 0.646*** |
| | (0.072) | (0.073) | (0.060) | (0.060) |
| Observations | 168 | 225 | 296 | 296 |
| Number of participants | 11 | 14 | 14 | 14 |

Table 9: Results from OLS regressions for low-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Hire | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.467*** | 0.622*** | 0.729*** | |
| | (0.105) | (0.090) | (0.050) | |
| Removing AA | 0.193 | -0.003 | 0.330** | 0.330** |
| | (0.119) | (0.097) | (0.129) | (0.129) |
| Introducing AA (first half) | | | | 0.754*** |
| | | | | (0.047) |
| Introducing AA (second half) | | | | 0.695*** |
| | | | | (0.091) |
| Constant | 0.173*** | 0.190*** | 0.196*** | 0.196*** |
| | (0.042) | (0.035) | (0.047) | (0.047) |
| Observations | 249 | 191 | 220 | 220 |
| Number of participants | 16 | 14 | 11 | 11 |

Table 10: Results from OLS regressions for high-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Firm Belief | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.000 | -0.027 | 0.033 | |
| | (0.050) | (0.055) | (0.041) | |
| Removing AA | -0.180** | 0.045 | 0.015 | 0.015 |
| | (0.081) | (0.036) | (0.037) | (0.037) |
| Introducing AA (first half) | | | | 0.022 |
| | | | | (0.053) |
| Introducing AA (second half) | | | | 0.045 |
| | | | | (0.038) |
| Constant | 0.700*** | 0.774*** | 0.704*** | 0.704*** |
| | (0.064) | (0.067) | (0.058) | (0.058) |
| Observations | 243 | 214 | 444 | 444 |
| Number of participants | 17 | 14 | 23 | 23 |

Table 11: Results from OLS regressions for non-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Firm Belief | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.084 | 0.091 | 0.144*** | |
| | (0.063) | (0.062) | (0.044) | |
| Removing AA | 0.034 | -0.066 | 0.079** | 0.079** |
| | (0.060) | (0.054) | (0.034) | (0.034) |
| Introducing AA (first half) | | | | 0.114** |
| | | | | (0.045) |
| Introducing AA (second half) | | | | 0.169*** |
| | | | | (0.050) |
| Constant | 0.441*** | 0.480*** | 0.626*** | 0.626*** |
| | (0.066) | (0.058) | (0.055) | (0.055) |
| Observations | 168 | 225 | 296 | 296 |
| Number of participants | 11 | 14 | 14 | 14 |

Table 12: Results from OLS regressions for low-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| VARIABLE: Firm Belief | Subsidy (1) | High Subsidy (2) | Long Subsidy (3) | Long Subsidy (4) |
|---|---|---|---|---|
| Introducing AA | 0.177** | 0.140** | 0.395*** | |
| | (0.079) | (0.061) | (0.074) | |
| Removing AA | 0.204** | 0.021 | 0.285** | 0.285** |
| | (0.090) | (0.054) | (0.108) | (0.108) |
| Introducing AA (first half) | | | | 0.388*** |
| | | | | (0.063) |
| Introducing AA (second half) | | | | 0.404*** |
| | | | | (0.106) |
| Constant | 0.321*** | 0.370*** | 0.385*** | 0.385*** |
| | (0.055) | (0.040) | (0.066) | (0.066) |
| Observations | 249 | 191 | 220 | 220 |
| Number of participants | 16 | 14 | 11 | 11 |

Table 13: Results from OLS regressions for high-discriminatory firms. Standard errors are shown in parentheses and are clustered at the individual level. Significance levels are indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

| | Seed Stage | Baseline Stage | Introducing AA | Removing AA |
|---|---|---|---|---|
| Subsidy | 0.00 | 0.05 | 0.48 | 0.07 |
| High Subsidy | 0.05 | 0.07 | 1.00 | 0.21 |
| Long Subsidy | 0.06 | 0.17 | 0.90 | 0.40 |

Table 14: Fraction of firms hiring a PURPLE worker over a GREEN worker

# 6 Choice from a Menu

In our experiments, each firm is randomly paired with a particular worker and faces a binary hiring decision. In a labor market setting, however, firms are typically confronted with the choice of *which* worker to hire from a menu of workers. The efficacy of an affirmative-action policy would then be measured by its ability to nudge firms to hire certain worker types from a menu containing their favored workers. Our data allow us to deduce expected choices from such worker menus with and without affirmative-action policies in place. That is, we can use our data to deduce how often firms would hire a PURPLE worker when given the choice of hiring either type of worker. This extrapolation exercise is certainly merely suggestive: it hinges on the assumption that participants change neither their actions nor their beliefs as a response to the availability of a menu. We describe the details of our calculations below.

In each round of the experiment, firms are asked to report their belief about the likelihood that the workers they are paired with chose to invest in training. Similarly, workers are asked to report their belief about the likelihood that the firms they are paired with chose to hire them.[4] Using these belief elicitations, we first calculate each firm's average reported beliefs for GREEN and PURPLE workers' investment rates in each stage of the experiment. Using these, we then calculate each firm's expected payoffs from hiring GREEN and PURPLE workers in each stage of the experiment. In the main text, we show that firms best respond to their reported beliefs. We therefore assume that, when faced with a menu, a firm would hire a PURPLE worker only if her expected payoff of hiring a PURPLE worker is strictly greater than her expected payoff of hiring a GREEN worker. Table 14 shows the fraction of firms hiring a PURPLE worker over a GREEN worker under these assumptions (using the shorthand AA for affirmative action).

Consistent with the paper's findings, we see that PURPLE workers would be hired at a significantly higher rate when affirmative action is introduced (two-sided t-test: $p < 0.001$ in all three treatments). However, when affirmative action is removed, the hiring rate for PURPLE workers would decline substantially. For the Subsidy treatment, in fact, the hiring

[4]As mentioned in the paper, we use the binarized scoring rule of Hossain and Okui (2013) to incentivize belief elicitation. This rule is incentive-compatible even for decision-makers who are not risk-neutral.

rate for PURPLE workers after the policy intervention would not be significantly different than prior to the policy intervention (two-sided t-test: $p = 0.65$). For the High Subsidy and Long Subsidy treatments, we find that there would be modestly significant differences in the hiring rates of PURPLE workers before and after the policy interventions (two-sided t-test: $p = 0.06$ for High Subsidy, $p = 0.01$ for Long Subsidy). Again, this underscores the point that stronger affirmative-action policies can have longer-lasting positive effects.

To conclude, by extrapolating our belief-elicitation data, we derive predictions for a richer market environment that echo our main findings. Statistically discriminated-against workers, who compete against more initially "desirable" workers, benefit from affirmative-action policies, but often only while those policies are still in place.

# References

Tanjim Hossain and Ryo Okui. The binarized scoring rule. *Review of Economic Studies*, 80(3):984–1001, 2013.