



# Referrals and information flow in networks increase discrimination: A laboratory experiment

Károly Takács<sup>a,\*</sup>, Giangiacomo Bravo<sup>b</sup>, Flaminio Squazzoni<sup>c</sup>

<sup>a</sup> MTA TK “Lendület” Research Center for Educational and Network Studies (RECENS), Centre for Social Sciences, Hungarian Academy of Sciences, Tóth Kálmán u. 4., 1097 Budapest, Hungary

<sup>b</sup> Department of Social Studies and Centre for Data Intensive Sciences and Applications, Linnaeus University, Universitetsplatsen 1, 35195 Växjö, Sweden

<sup>c</sup> Department of Economics and Management, University of Brescia, Via San Faustino 74B, 25122 Brescia, Italy

## ARTICLE INFO

### Article history:

Received 8 August 2017

Received in revised form 19 March 2018

Accepted 22 March 2018

### Keywords:

Hiring discrimination

Referrals

Recommendations

Information networks

Labor market

Laboratory experiment

Quality standards

## ABSTRACT

Referrals and information flow distort market mechanisms of hiring in the labor market, but they might assist employers under asymmetric information in finding better alternatives. This paper investigates whether an impartial information flow between employers in a cyclic network structure could generate more discrimination than when no information is exchanged between employers. We set up an artificial labor market in which there was no average quality difference between two categories of workers. We asked participants to play the role of employers and examined the partiality of their hiring choices. Results showed that discrimination was prevalent in all conditions. Higher standards by the employers for the quality of workers increased discrimination as did the presence of referrals from workers. Unexpectedly, impartial information flow in a cyclic network of employers did not help to decrease discrimination. We also showed that these mechanisms interact with and subdue each other in complex ways.

© 2018 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

Hiring discrimination means differential treatment of a certain social category, based on category membership rather than individual merit. Differential treatment is recurrent in hiring choices characterized by asymmetry of information between the organization and the applicant (Petersen and Saporta, 2004; Rooth, 2010). Given that the true worker's quality cannot be accurately predicted during hiring decisions, organizations might use recognizable traits (e.g., race and gender) as inexpensive screening devices when hiring for jobs, particularly skilled jobs, in the belief (correct or not) that race and sex status are, on average, related to productivity' (Kaufman 2002, p. 550). When there is no or little statistical basis to distinguish the quality of members of different categories, following recognizable traits cannot help to estimate the applicant's quality. In these cases, understanding why discrimination could persist is of paramount importance (Bertrand et al., 2005).

\* Corresponding author at: MTA TK “Lendület” Research Center for Educational and Network Studies (RECENS), Centre for Social Sciences, Hungarian Academy of Sciences, Tóth Kálmán u. 4., 1097, Budapest, Hungary.

E-mail addresses: [takacs.karoly@tk.mta.hu](mailto:takacs.karoly@tk.mta.hu) (K. Takács), [giangiacomo.bravo@lnu.se](mailto:giangiacomo.bravo@lnu.se) (G. Bravo), [flaminio.squazzoni@unibs.it](mailto:flaminio.squazzoni@unibs.it) (F. Squazzoni).

Hiring decisions might reflect signals and information that channel through social networks. The important role of referrals in particular is well documented for getting a job (Granovetter, 1973, 1974; Lin et al., 1981; Wegener, 1991; Elliott, 2001; Mouw, 2002; Fernandez and Fernandez-Mateo, 2006; Ponzo and Scoppa, 2010; Fountain and Stovel, 2014). Many studies argued that getting a job via referrals might distort the perfect market logic and replace meritocratic processes in hiring (Ioannides and Loury, 2004; Petersen et al., 2000; Tassier and Menczer, 2008). For instance, the extended use of informal job search methods may have a negative effect on the rate of mobility from low status to high status jobs (McBrier 2003; 1212). If one of the groups has a better access to informal job search, this is detrimental for the other group, as in the case of referrals from the “old boys” network in a wide range of contexts (Rogers, 2000; McBrier, 2003; McDonald, 2011; Bian et al., 2015).

Research concerning referrals highlighted how the hiring mechanism could enhance inequality of employment and wages (Montgomery, 1991; Krauth, 2004; Fontaine, 2008). Given that contacts might be homophilous with regard to internal quality, the extensive use of referrals lead necessarily to growing inequality (Montgomery, 1991; Beaman and Magruder, 2012). Considering that contacts are homophilous also with regard to social characteristics that are uncorrelated with ability, research showed that initial differences in the employment rate could result in greater wage inequalities over time (Montgomery, 1991; Arrow

and Borzekowski, 2004). Exogenously provided job information that is passed on via network ties also enlarges small initial differences (Calvó-Armengol and Jackson, 2004, 2007).

A few studies looked at referrals (Engström et al., 2012; Beaman and Magruder, 2012; Beaman et al., 2013; Caria and Hassen, 2013; Fernandez and Greenberg, 2013) and other structural mechanisms that affect discrimination (see Olian et al., 1988 for an earlier meta-analysis). Our paper aims to study structural mechanisms that can influence differential hiring practices *experimentally*.

The main advantages of the experimental methodology are that: (a) the hypothesized correlations can be tested unambiguously in a fully controlled environment that excludes confounding effects (e.g., Smith, 1991; Roth, 1993; Webster and Sell, 2007); (b) generative relations can be identified; (c) replication of findings is possible (e.g., Chapin, 1932; Falk and Fehr, 2003; Willer and Walker, 2007; Fehr and Gintis, 2007; Bohnet, 2009; Falk and Heckman, 2009; Smith, 2010). It is worth noting that experimental studies might help us to identify mechanisms that can be empirically examined in different contexts (Camerer, 2003; Ostrom, 2010; Ariely, 2008; Falk and Heckman, 2009).

Classical and recent small group experiments in social psychology testified to the human tendency to discriminate unknown partners based on category membership (e.g., Brewer, 1979, 1996; Dovidio et al., 2002; Fiske, 2009). Similarly, recent laboratory and field studies in economics and sociology confirmed the existence of discriminative practices (e.g., Solnick and Schweitzer, 1999; Pager et al., 2009; Jackson, 2009; Midtbøen, 2014; Agerström, 2014; Lee et al., 2015). Some laboratory studies were able to isolate important behavioral effects and interactional influences in discrimination (e.g., Keuschnigg and Wolbring, 2015; Takács et al., 2015; Lane, 2016).

Very few studies have tried to analyze factors related to social capital in hiring experimentally (Godechot, 2016). This can be explained as it is very difficult to depict the complex characteristics of social capital in the laboratory, causing concerns of external validity. But exactly due to the complex nature of social capital related processes, field research cannot fully disentangle the informational aspects of social capital from other mechanisms on discrimination. By contrast, carefully designed experiments using simple network structures can provide us a truly causal account by focusing on specific mechanisms inherent in the relational structure (Kosfeld, 2004; Willer and Walker, 2007; Gërxhani et al., 2013; Brashears and Quintane, 2015; Brashears and Gladstone, 2016). In our case, the experimental design can concentrate and rely on some elementary and empirically relevant mechanisms that potentially determine discrimination in hiring. One of these mechanisms covers referrals coming from workers. Another one summarizes the information flow coming from other employers who are very much in the same situation and have similar goals. Acquiring, passing on, and exchanging information between employers about employees is very difficult to trace in field studies. Tags and signals that characterize workers are also multi-dimensional, some correlate with internal qualities and skills, while others do not. As our study demonstrates, these mechanisms can be abstracted and used in the lab. In order to allow for causal inference, our laboratory experiments exclude concerns about strategic choices and endogeneity in recommendations and referrals by design.

It analyzes hiring decisions in a controlled setting and is able to reduce the high dimensionality of reality into a straightforward model.

Given the complexity of hiring choices in the labor market, empirical field research is unable to test univocally whether referrals increase discrimination compared to a baseline case without referrals or not. Furthermore, it cannot be explored whether referrals make a difference also without any initial biases or alternatively, observed inequalities are there because of historical path

dependence. Besides, in existing field studies, worker referrals and information flow among employers are considered jointly and their impacts are hardly separated.

In order to overcome these empirical difficulties, following Takács et al. (2015), we have designed a labor market experiment where participants (university students) were asked to play the role of *employers* and select *fictive workers* belonging to two categories. In our experiment, by excluding contextual effects and other important aspects of the hiring process, we tested the net and the joint effects of *referrals*, *information flow from other employers*, and *quality standards* on discrimination.

*Referrals* have been defined as recommendations for hiring by workers in-house (Montgomery, 1991; Fountain and Stovel, 2014). Referrals are naturally biased towards members of the in-group. This characteristic feature has been depicted in our experimental design. *Information flow* has been conceptualized as an automated process in a simple directed network of employers. This conceptualization covers multiple mechanisms according to which employers get to know the true qualities of workers employed at connected firms; such as recommendation letters, information exchange, and observations that take place as a result of established contact between the organizations. *Quality standards* were evaluation thresholds set up exogenously to determine whether it is economical to keep workers in house or not.

In our experiment, representing an idealistic world, there was *no difference* in the mean and distribution of quality of workers in the two categories; hence the impact of historical path dependence and initial biases could be excluded. Note that significant elements of everyday interactions were neglected in our labor market laboratory. For instance, there was no recruitment procedure in the experiment as we were interested in discrimination when hiring decisions are made. Recruitment itself can add an extra layer of discrimination by selectively targeting certain groups or using biased information channels. Moreover, in reality, workers themselves could apply selectively by expecting discrimination. These complications are present in the field and would distort the evaluation of impartiality of hiring decisions in the lab.

Our research questions were as follows.

1. Does discrimination occur in an artificial labor market with balanced and fair conditions?
2. Do higher quality standards create more discrimination? Or in other words, if employers are rewarded only for high quality workers, will discrimination increase?
3. Do worker referrals increase discrimination?
4. Does flow of accurate information in a network of employers decrease discrimination?

These questions concern primarily the behavior of individual employers. In addition, we were also able to analyze whether occasional individual biases balance each other out or they add up to inequality of employment between groups in our artificial labor market with balanced and fair conditions.

## Hypotheses

### *An inclination towards discrimination*

As suggested by Takács and Squazzoni (2015), who built a simple model of an idealized labor market in which there was no objective difference in average quality between groups and hiring decisions were not biased, a certain level of discrimination could be expected also in an ideal world with impartial employers. Judgment errors of this kind could be the consequence of “rational” adaptive sampling of available information (cf. Simon, 1955; Denrell, 2005; Fiedler

and Juslin, 2006; Le Mens and Denrell, 2011; Denrell and Le Mens, 2011). That is, people make systematic judgment errors as they naïvely extrapolate from limited information available to them. Moreover, psychological studies indicated that individuals are to large extent also process information inaccurately or they rely on biased heuristics. They are constrained by selective attention and tend to retain information confirming their beliefs, while ignoring information that contradicts their expectations (e.g., Hamilton, 1981). An initial bias with sequential, path-dependent hiring decisions may result in persistent and self-reinforcing discriminative choices (e.g., Hoeffler et al., 2006). These expectancy confirmation sequences have been found in experimental research (Berger et al., 1980; Darley and Fazio, 1980) and are expected to influence also employer decisions in hiring processes. These considerations led us to formulate the following hypothesis:

**Hypothesis 1.** A non-zero level of discrimination is expected also in the baseline condition of no referrals in the idealistic experimental labor market.

#### *Higher standards and discrimination*

Higher quality standards for applicant qualities can originate in higher need for the best quality labor force, in more demanding tasks, in intense market competition, and in simple greediness. Employers who have high standards for applicants sort out candidates who would otherwise be able to conduct the job. After employment, employers with higher standards are not easily satisfied and experiment more with new hires. That is, higher standards are used for selection and also for keeping the labor force (e.g., Takács and Squazzoni, 2015). Higher standards are typical for high status jobs and for jobs where specialized knowledge or advanced skills are required. Advanced skills could be learnt after employment within house, but that requires expensive investments from the employer. These investments are easily lost if the employee quits the job. Turnover costs therefore are much higher in jobs that require advanced skills than in jobs that do not.

Greedy search (“over-searching”) that tries to seek better alternatives than an employee with the quality standard of the optimal reservation level conveys a loss (e.g., McCall, 1970; Stigler, 1961, 1962; Mortensen, 1986). A search that is extended beyond the alternative that is at least as good as the reservation level results in an expected relative loss not just because of search costs, but also because the average expected quality of new workers is smaller than that of the current alternative. Extended search and repeated failures imply that the higher quality standards also result in lower employer profits.

For the sake of simplicity, in our experiment, we assumed that employers have no opportunity to train their workers and they do not face differential turnover costs. We were primarily interested in the consequences of setting a higher quality standard exogenously for worker selection for labor market inequality.

A higher quality standard implies more experimentation with new workers. Information cues therefore could have a greater importance for employer decisions. In our experiment, the only available information cue was category membership. Its importance, therefore, is expected to increase for employers who are motivated to hire new workers with high quality. Hence, we expect that employers looking for high quality workers consider group markers more closely and, depending on available information, are inclined to develop biased group reputations. The few highly skilled workers whom they are satisfied with are kept in house and continue to bias the employer's judgment about available skills in the groups. Because of the larger perceived role of supplementary information and the over-representation of skilled workers kept in house for group reputation formation, higher discrimination rates

could occur for employers with higher quality standards. This led us to our second hypothesis.

**Hypothesis 2.** Higher quality standards lead to higher discrimination rates.

#### *Referrals and discrimination*

Social networks can be used in job hiring for two reasons. First, due to its affective content, a social tie creates an obligation for the worker in-house on one end and an opportunity for the job-seeker at the other end of the connection. Second, network ties are channels of gathering, conveying, and signaling information on hidden individual qualities. Depending on which aspect is more prevalent, referrals might have different consequences for discrimination (cf. Rubineau and Fernandez, 2015).

*Worker referrals* between current and prospective employees build on the *affective* content of relationships and are more concerned with the welfare of the applicant, less with employer benefits. This means that worker referrals do not necessarily reflect information on quality and do not allow the employer to find optimal matches in hiring. Consequently, if considered at all, worker referrals are not taken into account because of direct profit-seeking motives.

Worker referrals are based on social ties that are homophilous to a large extent in the ethnic and other important dimensions (McPherson et al., 2001; Rubineau and Fernandez, 2013). When referral networks are used in which ties are typically based on homophily, they cause labor market segregation (Model, 1993; Tilly, 1998; Elliott 1999, 2001; Kugler, 2003; Stovel and Fountain, 2009). With homophilous referrals, labor market segregation develops endogenously even with non-prejudiced agents (Barr, 2009).

Empirical work showed that members of a particular ethnic group tend to recommend others with the same ethnic background for a job (Elliott, 2001; Fernandez and Fernandez-Mateo, 2006). This can reinforce their disadvantaged position and exclude them from better jobs (Wilson, 1987). Therefore, the deficit of disadvantaged groups does not depend on the fact that they would rely less or more on networks in finding a job. Rather, it depends on the fact that they extensively rely on “wrong networks” that cannot offer them good jobs (Fernandez and Fernandez-Mateo, 2006; Petersen et al., 2000).

The characteristic feature of worker referrals that we entered in the laboratory is their homophilous character with regard to category membership. We assume that their presence reinforces the initial random delusions of employers about group differences (cf. Fernandez and Greenberg, 2013). Consequently, we can hypothesize that discrimination is stronger with worker referrals than in case of isolated, unconnected employers. As we are interested in the discrimination tendencies of employers, referrals by fictive workers in our experiment considered to be a random within-group process.

**Hypothesis 3.** Homophilous worker referrals increase discrimination rates.

#### *A network of information flow and discrimination*

In contrast to affective content of worker referrals, the flow of accurate and relevant information between employers about workers could decrease information asymmetry in hiring decisions (Fernandez et al., 2000; Elliott, 2001). With a correct view on individual qualities in a larger pool of workers, employers could arrive at better informed decisions. This is in line with the empirical fact that recommendations from business partners and respected employers are considered seriously at job interviews. Surveys of personnel officers found that recommendations from a manager



were more important for hiring than objective signals, such as high school grades (Rosenbaum et al., 1990; Spoonley 2008: 27).

When employers are isolated and base decisions only on their own experience, decisions could be biased in favor of one group or another. If additional information is received about the qualities of individual workers and groups, then the increased amount of information is expected to decrease the statistical bias from individual sampling. In order to provide standardized conditions for hiring decisions, information flow is considered as an automated process in our experiment. Please note that we designed our experiment to guarantee that the information exchanged is accurate. Hence, we avoided the strategic complexity of recommendations in business life for the sake of simplicity.

Employers were arranged in a simple circular network. Related experimental research on coordination in circular networks has found mixed evidence about convergence towards a single consensus (Keser et al., 1998; Berninghaus et al., 2002).

Biases of individual employers favoring one group or another are expected to balance each other out at the aggregated level of the fair labor market. Information flow between employers, however, creates network externalities as employers might be prone to *social influence*. In a perfectly balanced idealistic world as represented in our experiment, social influence (Takács et al., 2016; Flache et al., 2017) and the “wisdom of the crowd” (Galton, 1907; Surowiecki, 2005; Lorenz et al., 2011) are expected to drive the group towards consensus. Flow of trusted information between employers could be viewed as an insurance device (cf. Gemkow and Neugart, 2011) that bring markets closer to perfection, thereby decreasing inequality in employment. Experiments show, however, that an average initial bias and even mild social influence could undermine the wisdom of the crowd (Lorenz et al., 2011), implying that in our case social influence could enlarge rather than diminish inequality in employment.

This led us to formulate the following hypothesis at the level of individual employers that could, but not necessarily translated to more balanced employment chances at the aggregated level.

**Hypothesis 4.** Access to reliable information in the network of employers about individual worker qualities decreases discrimination rates.

#### Interaction effects

Higher quality standards are expected to increase discrimination when there is asymmetry of information, because employers are more disappointed with new labor force and rely extensively on few high quality workers kept in house (Takács and Squazzoni, 2015). At the same time, additional and trusted information from other employers could reduce this bias and even improve the situation. This is because employers are more motivated to hire quality workers and could overcome their intrinsic partiality for one of the groups as soon as adequate information becomes available.

For the employers, worker referrals enlarge the pool of workers from the category that is already overrepresented. As high standards increase the turnover rate and employers continue to follow their workers' advices, this could potentially result in a positive interaction effect (e.g., Takács et al., 2015). We have examined these potential interaction effects in our experiment by the inclusion of treatments in which a mixture of our manipulations was present.

## Method

### Experimental design

We designed an experiment where participants played the role of employers and asked to hire workers for their firm. Par-

ticipants played anonymously in groups of six, with two groups playing simultaneously in the same laboratory to avoid identification of other group members. They interacted through a computer network running the experimental software z-Tree (Fischbacher, 2007). Participants were asked to imagine that they were employers and were invited to hire 10 workers per period, which represented one contract year.

Workers were virtual agents and had ID numbers from 1 to 200. Each worker had a fixed quality drawn from a uniform integer distribution in the  $[0, 19]$  interval at the beginning of the game. Half of the workers were labeled as ‘blues’, half as ‘greens’. Colors were not related to the quality of workers: the distribution of quality was, on average, the same for blues and greens. Subjects were not aware of the exact distribution of qualities. Their instructions, however, contained that “There are plenty of BLUE and GREEN workers in the market with a maximum quality value” (Supp. Mat.). In short, subjects were not aware of any initial difference between the workers' groups that could be responsible for individual discrimination and such difference in fact did not exist.

In all experimental conditions, participants could select each worker using one of the following options: (i) hiring a worker randomly; (ii) hiring a blue worker randomly; (iii) hiring a green worker randomly; (iv) hiring one of the workers they hired in the previous period. To allow participants to use (iv), the list of workers hired in the previous period, including their quality and color, was displayed on their screen (Supp. Mat.). These options were supplemented in the respective experimental conditions with (v) hiring workers that were hired by the connected employer in the previous period (information flow) and (vi) hiring workers referred by workers in-house.

After the hiring stage (i.e., at the end of each period), participants were asked to provide an estimation of the average quality of both blues and greens in the entire pool, which served to measure their actual beliefs and prejudice. We simulated turnover (random fluctuation) by excluding 10 per cent of workers from the list displayed to subjects in each round. Excluded workers were unavailable for hiring with procedure (iv).

Each experiment included 25 periods. The profit of employers depended on the quality of hired workers, which was unknown before hiring except that of workers hired in the previous period. Low and high quality standards were implemented with the following exogenous threshold rule. The threshold was  $\tau = 12$  in the case of low quality standards ( $-S$ ) and  $\tau = 17$  in the case of high quality standards ( $+S$ ). Thresholds were imperative for individual payoffs. Specifically, profit was calculated by summing the quality of workers with  $q_i \geq \tau$ , and dividing the result by ten (the number of jobs at the firm). Therefore, quality standards were set up by design in the experiment.

At the end of each period, the average quality of blue and green workers hired by the participant was calculated and displayed with the number of points earned. At the end of the experiment, participants were asked to complete a short questionnaire. Individual profits were averaged across all 25 periods, with each point being exchanged with one Euro. Earnings were cashed immediately after the end of the experiment.

We followed a between-subjects  $2 \times 2 \times 2$  full factorial design. We manipulated: a) high or low quality employer standards, b) the presence of information flow between employers, and c) the presence of worker referrals (Table 1). Therefore, we included eight treatments, i.e., four testing for effects of these manipulations alone and four examining their interactions.

In case of information flow between employers ( $+E$ ), each participant was linked to another employer in a *directed circle network* with six nodes (Fig. 1). Instructions referred to employer network ties as “friends” (Supp. Mat.). This reference has been made in order to increase the credibility of information conveyed and to make the

**Table 1**  
Treatment overview.

	Treatment	High standards	Information flow	Worker referrals
Pure effects	–S –E –W			
	+S –E –W	■		
	–S +E –W		■	
	–S –E +W			■
Interaction effects	+S +E –W	■	■	
	–S +E +W		■	■
	+S –E +W	■		■
	+S +E +W	■	■	■

experimental situation more realistic. In the information flow condition (+E), own workers hired in the previous period, and those hired in the previous period by the friend were displayed automatically, including color and quality of workers without any error. The average quality of blue and green workers hired by the friend was also displayed. To enhance information flow further, subjects received their friends' estimates about the average quality of blues and greens. In the information flow condition (+E), subjects could also select a worker who was hired by the business friend in the previous period (selection procedure v). Note that this meant that the same worker could be hired by two or more participants in the same period and best workers were not subject to competition by business friends. This excluded the possibility that decision speed would determine which employer hires a worker with superb quality. Participants did not know the entire network structure; hence strategic considerations were unimportant for who could hire the best workers. In case of no information flow (–E), no network existed and none of the subjects knew the workers hired by other subjects or others' estimations of workers' quality.

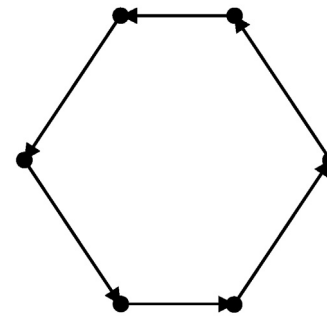
In the worker referrals condition (+W), each worker hired in the previous period 'recommended' a friend of the same color, randomly selected, without revealing its quality. The suggested workers were shown in a specific list on the participants' screen. In case of worker referrals (+W), subjects could select a worker from this list (selection procedure vi). In case of no worker referrals (–W), participants did not have a list of recommended workers. Participants were fully aware that workers will give a homophilous referral (see full instructions in Supp. Mat.).

### Subjects

A total of 144 subjects (56 per cent females) forming 24 groups participated in the experiment, which was held in the GECS computer lab of the Department of Economics and Management of the University of Brescia, Italy. Subjects were university student volunteers recruited across all university faculties using the online platform ORSEE (Greiner, 2004). They gave informed consent. Participant earnings averaged to €12.49 (std. dev. €3.65), plus a fixed show-up fee of €5. The experiment, including instruction reading and a final questionnaire, took approximately one hour. The full instructions for participants are included in the Supplementary Material.

### Discrimination indexes

We defined *micro level discrimination* as the average extent to which individual participants hired workers from a single group as our main dependent variable. The micro level discrimination index  $\delta_{it}$  takes an individual value for each participant  $i \in \{1, \dots, 144\}$  in each period  $t \in \{1, \dots, 25\}$ . It was defined as one minus the ratio of the number of workers of the more discriminated group hired by  $i$



**Fig. 1.** The information flow network in the experiment.

Note: No network information was given to the subjects. Subjects have received the following instruction in treatment (+E): "During the experiment, some of the other employers will be considered as 'your friends'. As friends communicate with each other, your friend employers will share information about the workers they employ. Hence, in these situations, you will get to know the quality of the workers employed by your friends and you can also select a worker from this list, which will be displayed in the middle of your screen. In this case, you will be able to select workers whom your friends employed in the previous year..."

in period  $t$  to the number of hired workers of the less discriminated group. Formally:

$$\delta_{it} = \begin{cases} 1 - \frac{H_{it}^g}{H_{it}^b} & \text{if } H_{it}^g \leq H_{it}^b \\ 1 - \frac{H_{it}^b}{H_{it}^g} & \text{if } H_{it}^g > H_{it}^b \end{cases} \quad (1)$$

where  $H_{it}^b$  was the number of hired blues and  $H_{it}^g$  was the number of hired greens by participant  $i$  in period  $t$ . Eq. (1) shows that  $\delta_{it}$  was 0 in case of no discrimination and 1 if all workers were of the same color, with intermediate cases of discrimination falling in between.

To analyze whether one group is favored over another one and discrimination tendencies spread or balance each other, we also defined *macro level discrimination* as the objective extent to which groups were disproportionally hired in the given period. This is important because, although individual employers might be perfect discriminators, this may not generate employment inequality if mutual discrimination tendencies across different firms are balanced.

The macro-level discrimination index  $\Delta_t$  is similar to the micro-level index but is defined at the group level. More specifically, it was calculated as one minus the ratio of the number of workers of the more discriminated group hired by all the six employers to the workers of the less discriminated group hired. This means that  $\Delta_t$  took a single value in each period  $t$  and its mathematical formulation was equivalent to Eq. (1) but  $H_{it}^b$  and  $H_{it}^g$  were computed as the sum of all blues and green hired in period  $t$ . As for the micro-level index,  $\Delta_t$  was 0 for no inequality in employment and increased with increasing discrimination up to 1.

## Results

### Testing for pure effects

We will present our results in three steps. First, we will discuss results from the no-interaction treatments, in which only one manipulation was introduced at once. This will help to highlight the pure effect of high quality standards, information flow, and worker referrals on discrimination. Second, we will discuss results on discrimination from all treatments that included also interactions. Third, we will analyze employer earnings. Although payoffs were not essential to our main research questions, their analysis has important economic implications.

**Table 2**

The number of workers hired through different options.

Treatment	New workers randomly (i–iii)	Re-hiring workers (iv)	Hiring from employer contact (v)	Hiring via worker referrals (vi)	Total (i–vi)
<i>no-interaction treatments</i>					
–S –E –W	1827	2651			4478
+S –E –W	3093	1405			4498
–S +E –W	782	2542	1155		4479
–S –E +W	1212	2493		792	4497
<i>interaction treatments</i>					
+S +E –W	820	2708	951		4479
–S +E +W	719	2136	1280	351	4486
+S –E +W	1439	2043		985	4467
+S +E +W	745	2005	1209	510	4469
Total	10,637	17,983	4595	2638	35,853

Note: N = 3600 hiring decisions with a maximum of 10 workers per decision.

**Table 3**

Means and standard deviations of discrimination indexes in no-interaction treatments.

Treatment	<i>micro-level discrimination index</i>				<i>discrimination index in rehiring</i>				<i>macro-level discrimination index</i>			
	N	Mean	SD	SE	N	Mean	SD	SE	N	Mean	SD	SE
–S –E –W	450	0.283	0.275	0.013	400	0.367	0.275	0.014	75	0.173	0.060	0.034
+S –E –W	450	0.426	0.301	0.014	361	0.514	0.500	0.017	75	0.238	0.015	0.009
–S +E –W	450	0.366	0.227	0.011	402	0.466	0.293	0.015	75	0.322	0.116	0.067
–S –E +W	450	0.438	0.313	0.015	402	0.516	0.325	0.016	75	0.204	0.031	0.018

Note: The macro-level discrimination index could only be affected logically in the –S + E–W treatment.

**Table 4**Mixed-effects regression on the micro-level discrimination index in no-interaction treatments ( $N = 1800$ ), with random effects for individuals and groups. The degrees of freedom were computed using Satterthwaite's approximation.

(Intercept)	Estimate	SE	<i>t</i>	<i>p</i>	Estimate	SE	<i>t</i>	<i>p</i>
	0.283	0.042	6.736	0.000	0.239	0.083	2.892	0.006
<i>treatment effects</i>								
+S	0.143	0.060	2.406	0.043	0.150	0.063	2.392	0.045
+E	0.082	0.060	1.384	0.204	0.090	0.064	1.406	0.196
+W	0.154	0.060	2.595	0.032	0.161	0.063	2.552	0.035
<i>subject characteristics</i>								
male					0.018	0.036	0.499	0.619
religious					0.006	0.038	0.166	0.868
economics					0.006	0.043	0.140	0.889
study year					0.011	0.013	0.859	0.394
part 2					–0.016	0.012	–1.385	0.166
F	35.507			0.000	8.479			0.001

Note: The dummy variable “economics” had a value of one if the participant was studying economics or management.

The upper four rows in Table 2 show that all available hiring methods (i–vi) were selected frequently by participants in the no-interaction treatments. Re-hiring of workers (iv) was favored to hiring workers from employer contacts (v) and to hiring via worker referrals (vi). Re-hiring was more common in the low quality standards condition. Higher quality standards resulted in more churn and experimentation with new workers. Table 3 displays an overview of mean  $\delta_{it}$  values in no-interaction treatments. All factor manipulations produced significantly higher discrimination than the baseline (Wilcoxon rank sum tests on individual averages:  $W = 83$ ,  $p = 0.006$  for +S;  $W = 110$ ,  $p = 0.052$  for +E;  $W = 89$ ,  $p = 0.010$  for +W; all  $p$  values are one tailed).

Note that discrimination index values cannot be fully attributed to one method of hiring or another as participants could re-hire workers or select other hiring methods in every round. They typically used combined strategies and might have individually compensated for their own bias in one type of hiring by favoring another group when choosing another hiring method. Still, in order to see the extent of discrimination that could potentially be linked to keeping workers in house selectively, we calculated  $\delta_{it}$  values for re-hires only. Table 3 shows these mean values (see middle columns). It is remarkable that participants were more biased

in favor of one group when re-hiring workers. The discrimination index for re-hires was higher in every experimental condition than the mean discrimination value for other hiring methods. Although these factors are intertwined, it is probable that discrimination by group membership was more influential in keeping workers than hiring new ones.

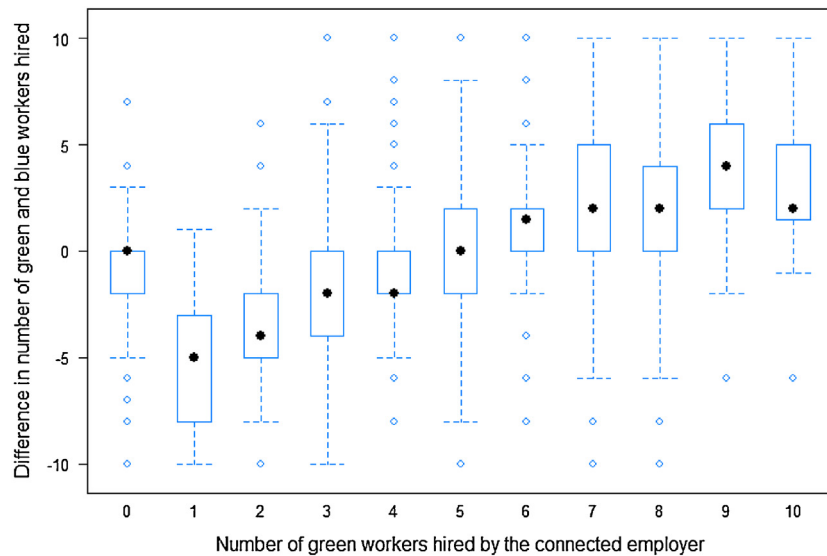
As our data included repeated observations of the same individual, we estimated a mixed-effects model with random effects at the individual and group level (hereafter ME model). There could be further dependencies in our data as current choices might have been influenced by earlier experiences in different ways (cf. e.g., Ule, 2008; Corten, 2009). As we are not interested in the exact nature of these dependencies, they are covered by individual-level effects, the experimental part dummy and the other controls included in the model. Table 4 shows the results of the model. The positive intercept indicates that a significant level of discrimination occurred in all treatments. Results supported our first hypothesis.

Results confirmed also Hypothesis 2, as higher quality standards resulted in higher discrimination rates. As formulated in Hypothesis 3, worker referrals (+W) increased discrimination rates. Meanwhile, Hypothesis 4 was not supported as the information flow (+E) coefficient was not significant and, if anything, this factor



**Fig. 2.** Social influence on discrimination in the information flow (+E) treatment.

Notes:  $N = 1800$  decisions. Positive values indicate bias towards greens and negative values indicate bias towards blues. Cases at the zero point are impartial judgments. Fitted smooth regression line is indicated.



**Fig. 3.** Confirmation bias in the information flow (+E) treatment.

Notes:  $N = 1800$  decisions. Positive values indicate bias towards greens and negative values indicate bias towards blues. Cases at the zero point are impartial judgments.

tended to increase rather than decrease discrimination. It is important to note that control variables included in the model, i.e., gender, religion, faculty study year had no significant effect. We also controlled for a possible experimental learning (or fatigue) effect by including a dummy and found no significant differences between the first and second half of the experiment.

Regarding macro-level discrimination, index values show that individual tendencies to discriminate have been balanced out to a large extent at the macro level (Table 3). The  $\Delta_t$  value of 0.173 in the –S–E–W baseline condition corresponds to an imbalance of hiring a total of 32.84 workers from one group and 27.16 workers from the other group on average (out of 60). The information flow treatment (+E), however, led to higher discrimination than the baseline (Table 3). This was the manipulation under which participants could have been affected by the selection of another employer. The higher  $\Delta_t$  value implies that individual discrimination tendencies ruled each other out to a lesser extent. The somewhat higher macro-level discrimination index in the information flow (+E) condition

implies that some employers have adopted the biases of or have been influenced by their contacts. Fig. 2 displays that while the most decisions were free of bias, participants slightly increased the partiality of their decision favoring the group of workers that had a higher average quality at the connected employer. Hence, participants partly adapted their sampling rationally given the new available information (cf. Le Mens and Denrell, 2011). Fig. 3 highlights more evidently that discrimination was contagious in the information flow treatment (+E). A larger bias by the connected employer resulted in larger discrimination in favor of the same group of workers, and therefore discrimination was subject to social influence in the experiment.

#### Interaction effects

The lower four rows in Table 2 show that all available hiring methods (i–vi) were selected frequently by participants in the interaction treatments. Re-hiring of workers (iv) was always the

**Table 5**

Means and standard deviations of discrimination indexes in interaction treatments.

Treatment	micro-level discrimination index				discrimination index in rehiring				macro-level discrimination index			
	N	Mean	SD	SE	N	Mean	SD	SE	N	Mean	SD	SE
+S +E –W	450	0.224	0.206	0.010	421	0.356	0.300	0.015	75	0.146	0.110	0.013
–S +E +W	450	0.413	0.284	0.013	403	0.553	0.336	0.017	75	0.264	0.202	0.023
+S –E +W	450	0.477	0.334	0.016	403	0.633	0.336	0.017	75	0.198	0.132	0.015
+S +E +W	450	0.483	0.292	0.014	370	0.592	0.328	0.017	75	0.385	0.178	0.021

Note: The macro-level discrimination index could only be affected logically in the +E treatments.

**Table 6**

Mixed-effects regression on the micro-level discrimination index including interaction effects ( $N = 3600$ ), with random effects for individuals and groups. The degrees of freedom were computed using Satterthwaite's approximation.

(Intercept)	Estimate	SE	<i>t</i>	<i>p</i>	Estimate	SE	<i>t</i>	<i>p</i>
	0.283	0.040	7.064	0.000	0.229	0.062	3.662	0.001
<i>treatment effects</i>								
+S	0.143	0.057	2.523	0.023	0.150	0.060	2.484	0.025
+E	0.082	0.057	1.451	0.166	0.084	0.061	1.379	0.186
+W	0.154	0.057	2.721	0.015	0.163	0.061	2.699	0.016
+S*+E	–0.284	0.080	–3.546	0.003	–0.292	0.086	–3.396	0.004
+S*+W	–0.104	0.080	–1.292	0.215	–0.117	0.086	–1.354	0.195
+E*+W	–0.107	0.080	–1.329	0.203	–0.118	0.086	–1.376	0.188
+S*+E*+W	0.314	0.113	2.769	0.014	0.335	0.123	2.732	0.015
<i>subject characteristics</i>								
male					0.008	0.024	0.349	0.728
religious					0.019	0.026	0.716	0.475
economics					0.027	0.028	0.950	0.344
study year					0.006	0.009	0.599	0.550
part 2					–0.000	0.008	–0.056	0.956
<i>F</i>	144.831			0.000	105.864			0.000

most favored option. Table 5 shows that discrimination in re-hiring was higher in every interaction treatment than micro-level discrimination in general. Hiring workers from employer contacts (v) and new hires altogether (i–iii) were more frequently used than worker referrals (vi) when they were available. Treatments including interaction between the manipulated factors generally led to *higher* micro-level discrimination than the baseline, except when employers with high standards benefited from information from other employers and worker referrals were not present (Table 5). All differences with the baseline (–S–E–W) were significant: –S+E+W, +S–E+W and +S+E+W led to higher discrimination ( $W = 82$ ,  $p = 0.005$ ,  $W = 70$ ,  $p = 0.002$  and  $W = 43$ ,  $p < 0.001$  respectively, all  $p$  values were one tailed), while +S+E–W led to lower discrimination ( $W = 226$ ,  $p = 0.022$ , one tailed).

We examined interaction effects by estimating a further ME model. Note that, unlike the previous models, all treatments were included in the analysis to control for pure effects. Several pure and interaction effects were significant in the new model (Table 6). The signs of all pure factor coefficients were positive, which is in line with the results presented in the previous section. All binary interactions led to *negative coefficients* but only the interaction of high quality standards and information flow (+S\*+E) was significant. Consistently with Hypotheses 2 and 3, high quality standards (+S) and worker referrals (+W) increased discrimination. In line with Hypothesis 4, information flow (+E) *decreased* discrimination, although that happened only in conjunction with high standards.

The coefficient for the interaction of high quality standards and information flow (+S\*+E) was sufficiently large to overcome the pure effects of the factors involved. This means that in the *specific case of high quality standards, information flow actually decreased discrimination*, despite the opposite pure effects of the two factors.

This could be explained as follows. On the one hand, in case of low quality standards, information flow increased discrimination via selective attention or confirmation bias. On the other hand, in case of high quality standards, when available information really

mattered, information flow decreased employer partiality. This implies that when there was a shortage of workers with acceptable quality, participants have realized the benefits of additional information and acted upon accordingly to avoid profit loss.

The interaction of high quality standards and worker referrals had a similar effect, although weaker. Given that there was no information benefit in the case of worker referrals, an increased alertness of employers with high quality standards could have reduced the partiality of their judgment. Our results also suggest that even the mutual presence of information flow between employers and worker referrals could have made employers more alert about partiality.

An alternative explanation of pairwise interaction effects is that information flow and worker referrals offset each other. This could have occurred when individual discrimination did not have a counterpart in terms of macro inequality and neighboring employers favored different groups. As the three-way interaction term shows, this balancing tendency occurred less likely for employers with high standards, who were pickier in their choices and trapped more likely by confirmation bias.

Except of the +S +E –W treatment that showed lower macro-level discrimination than the baseline, information flow (+E) led to a higher value of  $\Delta_t$  (Table 5). This implies that also in the interaction treatments, individual biases did not rule each other out completely in the presence of information flow between employers. This confirms some spread, but not an inevitable dissemination of biased evaluations in the network of employers.

#### Effects on participants' earnings

Participants' payoffs could be seen as a proxy for the general efficiency in the allocation of worker quality. Table 7 shows an ME model where the dependent variable was the payoff earned in each period of the game. Following the observation that higher quality standards resulted in more experimentation with new workers



**Table 7**  
Mixed-effects regression on participant's period earnings ( $N=600$ ), with random effects for groups. The degrees of freedom were computed using Satterthwaite's approximation.

(Intercept)	Estimate	SE	<i>t</i>	<i>p</i>	Estimate	SE	<i>t</i>	<i>p</i>
	12.388	0.639	19.375	0.000	10.415	0.941	11.074	0.000
<i>treatment effects</i>								
+S	−5.659	0.904	−6.259	0.000	−5.609	0.915	−6.129	0.000
+E	3.497	0.904	3.868	0.001	3.671	0.926	3.964	0.001
+W	−0.337	0.904	−0.373	0.714	−0.321	0.916	−0.351	0.730
+S * +E	4.603	1.279	3.600	0.002	4.361	1.303	3.346	0.004
+S * +W	2.654	1.279	2.075	0.054	2.549	1.303	1.956	0.068
+E * +W	−0.447	1.279	−0.349	0.731	−0.603	1.302	−0.463	0.649
+S * +E * +W	−2.820	1.808	−1.559	0.138	−2.461	1.854	−1.327	0.202
<i>subject characteristics</i>								
male					0.123	0.360	0.341	0.734
religious					−0.042	0.393	−0.108	0.914
economics					−0.278	0.422	−0.660	0.511
study year					0.150	0.140	1.074	0.285
part 2					3.218	0.105	30.521	0.000
F	472.233			0.000	440.719			0.000

1It is worth outlining that mixed effects models with individual and/or group-level random effects, although they are not always standard for experimental data analysis, represent an efficient method that can be profitably used to analyze the outcome of repeated games presenting interactions among participants (e.g., [Barrera and Buskens, 2009](#); [Boero et al. 2009a,b](#); [Bravo et al., 2015](#)).

(Table 2), quality standards had a direct impact on payoffs. Coherently with the rules of the game, higher quality standards led to lower profits. In contrast, the information flow (+E) treatment led to higher earnings that demonstrates the direct payoff benefits of additional available information.

Among the interaction effects, only the one between +S and +E one was positive and highly significant, while the one between +S and +W, also positive, was only significant at the 10% level. None of the individual variables was significant, while earnings clearly increased during the game. This was expected as participants could rely on a larger sample of workers whose quality has already been discovered over time.

## Discussion and conclusions

Due to the complexity of mechanisms and problems of their identification in the field, we have designed a laboratory experiment that is meant to test the existence of a baseline tendency for impartiality, the impact of a higher necessity of high quality workers, the influence of information flow in employer networks, and the role of referrals networks on discrimination in hiring choices. In the experiment, subjects played the role of employers. Representing asymmetric information in the real world, subjects were not aware of worker qualities in advance and had no prior knowledge about the distribution of quality for the two categories. In fact, worker qualities for the two categories were drawn from the same distribution and hence there was no reason for any impartiality in employer decisions. This neutral situation provided the best contrast to demonstrate the inevitability of discrimination.

We found that a substantial level of discrimination occurred across all treatments, confirming the presence of a baseline inclination for discrimination also in an impartial ideal world ([Takács and Squazzoni, 2015](#); [Takács et al., 2015](#)). This is against typical predictions by mainstream economists, according to which belief-related discrimination is not viable as employers not sharing false beliefs would gain a competitive advantage ([Arrow, 1973](#); [Aigner and Cain, 1977](#)). Accordingly, discrimination is costly: the most beneficial employment strategy in our experiment was to completely neglect color markers. There is little evidence, however, that employer practices reflect efficient and rational responses to differences in skills and turnover costs in reality ([Bielby and Baron, 1986](#); [Kaufmann et al., 2015](#)). This is confirmed by the persistence of discrimination in all conditions of our experiment.

We hypothesized that more discrimination could be induced by higher standards towards workers (Hypothesis 2). When standards are set high exogenously, lower quality workers are also employed by mere experimentation, and hence payoffs are also lower. Our findings suggest that higher standards generate a larger bias and inequality in hiring, confirming previous simulation findings ([Takács and Squazzoni, 2015](#)). Subjects acting as employers with high standards relied more on supplementary information of group membership of workers already in house rather than on the abundance of information on the qualities of workers screened before. In our experiment, employers with high standards kept a few highly skilled workers in house and this biased their judgment about the mean quality of social categories.

We do not want to convey the message that there is a general cognitive bias of human decision makers, which is correlated with higher desires and more selective preferences. Our results rather suggest that an unintentional adaptive sampling bias exists that originates from the over-generalization of the quality of the small sample of employees in house ([Denrell, 2005](#); [Le Mens and Denrell, 2011](#)). This adaptive sampling bias was more probable when employers with high standards were interested in the most qualified workers only (cf. [Polman, 2010](#); [Takács and Squazzoni, 2015](#)).

Considering complex cognitive mechanisms is not required to account for the emergence of discrimination, although complex cognitive mechanisms could in fact make things worse ([Takács et al., 2015](#)). The effect of high standards on discrimination could be enlarged by judgment bias, in particular by self-perceived objectivity ([Uhlmann and Cohen, 2007](#)), cherry picking, and confirmation bias (e.g., [Simon, 1955, 1956](#)). Another potentially relevant mechanism concerns expectancy confirmation sequences. In this case, individuals would be conditioned by selective attention leading them to consider only information that confirms their beliefs, while ignoring information that contradicts their expectations ([Hamilton, 1981](#); [Berger et al., 1980](#); [Darley and Fazio, 1980](#)).

Previous studies emphasized the relevance of social networks for inequalities of employment (e.g., [Montgomery, 1991](#); [Stovel and Fountain, 2009](#); [Beaman and Magruder, 2012](#)). Wages, job positions, or work conditions could depend on social networks (cf. [Montgomery, 1991, 1992](#); [Tian and Liu, 2018](#)). We emphasized that social network effects in hiring cannot be considered as a single mechanism. At least two very different mechanisms are at play (cf. [Gérxhani et al., 2013](#)). One is worker referral that facilitates labor

market segregation given their homophilous character. Another is information flow about workers via network ties of employers, for instance, in the form of recommendations or active search such as man-hunting. According to the first network mechanism, the affective content of social relationships could create obligations that make recommending and hiring friends more likely. This disrupts the basic logic of a 'perfect' market and results in suboptimal allocation of labor force (e.g., Ioannides and Loury, 2004; Tassier and Menczer, 2008).

Our results confirmed that worker referrals increase discrimination (Hypothesis 3). We found *increased* discrimination with worker referrals in our experiment, although we assumed no clustering of worker relations by quality. In a more realistic scenario, where workers are more likely to give referrals to workers of the same group and of similar quality, one could probably observe an even stronger bias favoring one group over the other (cf. Montgomery, 1991). When contacts are homophilous, referral networks can reduce inequality via an inverted advantage mechanism only if initial advantage is negatively correlated with the new status value (DiMaggio and Garip, 2012).

Contrary to our expectations (Hypothesis 4), information flow between employers *increased* discrimination. Previous studies showed that business contacts are important to reduce the effect of information asymmetry and help employers to evaluate properly the labor market potential of an employee (e.g., Rosenbaum et al., 1990; Uzzi, 1996). On the other hand, in case of difficult evaluation of quality, networks can enlarge false generalizations and might magnify the random initial bias. Even unprejudiced employers seek and rely on evaluations of others. In case of racial discrimination, this leads to what is known as racial profiling (Grogger and Ridgeway, 2006; Fernandez and Greenberg, 2013).

There is empirical evidence that people are largely influenced by their social network (e.g., Marsden and Friedkin, 1993) and follow advice sometimes even when they have direct observations (Sommerfeld et al., 2007; Gilbert et al., 2009). We obtained some evidence that in the information flow condition (+E) of our experiment, subjects playing employers were influenced to some extent by information they received. A difference in the mean quality values of workers hired by the connected employer made hiring from the better group more likely. Participants, therefore, have learnt from the experiences in their network, which is consistent with earlier research on learning in networks (e.g., Barrera and van de Bunt, 2009; Hofstra et al., 2015; Mason and Watts, 2012). At the same time, discrimination was probably not fully conscious and was not only due to rational social learning, as impartiality in hiring was often copied from the connected employer. Following the preferences of others is indicative of social influence that resulted in some bias contagion in the network. Furthermore, subjects could have devoted selective attention to the group reputation estimates of their contacts. They potentially confirmed their belief that had favored one of the groups if this was in accordance with the estimate of the other employer. Otherwise, if the estimate of the other employer was not in line with theirs, they probably handled this information with less attention. These factors altogether have resulted in some spread of discrimination in the network. Individual biases did not balance each other out completely, causing a certain extent of inequality in the information flow condition.

Furthermore, our results showed that these factors interact with each other in complex ways. It is important to note that the combined effect of these factors was not a statistical illusion due to the particular method used. We found that employers with high standards have made use of information flow in a way that decreased discrimination. The interaction of high quality standards and worker referrals had a similar diminishing impact.

It seems that networks contributed to more partial decisions of employers with high standards, who had to be more careful about

whom they employ (Takács and Squazzoni, 2015). Moreover, the joint presence of information flow between employers and worker referrals decreased discrimination, probably because group quality information originating from these sources offset each other. We also found a three-way interaction effect of high quality standards, information flow, and worker referrals. This interaction could have occurred because employers with high standards were more likely to fall into confirmation bias and neglected the more balanced joint perspective of information flow and worker referrals.

Obviously, our results need to be interpreted cautiously given the high level of abstraction of the study from the real labor market. Several important features of hiring processes were not covered in our experimental design. There was no application procedure and hiring by different employers took place simultaneously and was repeated in the same fashion several times. Participants were arranged according to a directed circle network and no other information flow structures were investigated. Workers were not decision makers, they in fact did not work, and their characteristics did not change over time. There were no differences in wages and every job was acceptable to workers. These and other empirically relevant characteristic features of the hiring process were excluded on purpose in order to illuminate the impact of quality standards, information flow in employer networks, and homophilous worker referrals on hiring discrimination.

Participants themselves playing the role of employers might have discounted the adequateness of the labor market framing for the decision situation. They might have perceived the decision task as an optimization problem that can be approached using a certain hiring strategy. In fact, this is not unrealistic at all, as many employees are strategic in their human relations policy and learn from the experience of others. Conclusions from our experiment, moreover, could be relevant to contexts other than the labor market. Quality standards, recommendations, and information flow are relevant factors in any repeated selection task. The same mechanisms potentially contribute, for instance, to consumer discrimination.

The idealistic conditions in the lab were aimed to highlight some fundamental tendencies of discrimination that could be strengthened, altered, or even cured in a complex institutionalized setting. In order to understand these aspects better, further empirical and field analysis is needed. Here, for instance, empirical studies that look at cross-cultural comparisons could enrich our understanding of social and institutional embeddedness of discriminative outcomes (e.g., Zschirnt and Ruedin, 2016; Tian and Liu, 2018). Providing a 'clean' test of certain simple hypotheses while leaving contextual effects in the background is an important step to understand employer discrimination and explore countermeasures that could help us reduce these distortions.

## Funding

Financial support for the conduct of the research has been provided by the Intra-European Fellowship Program of the European Union ("ODiscrimination", GA-2009-236953). The first author acknowledges support from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No 648693). We thank Marco Castellani and Niccolò Casnici for their practical help.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.socnet.2018.03.005>.

## References

- Agerström, J., 2014. Why does height matter in hiring? *J. Behav. Exp. Econ.* 52, 35–38. <http://dx.doi.org/10.1016/j.soec.2014.06.002>.
- Aigner, D.J., Cain, G.G., 1977. Statistical theories of discrimination in labor markets. *Ind. Labor Relat. Rev.* 30, 175–187.
- Ariely, D., 2008. Predictably Irrational. The Hidden Forces That Shape Our Decisions. Harper Collins, New York.
- Arrow, K.J. and Borzekowski, R., 2004. Limited Network connections and the Distribution of Wages. SSRN Working Paper. [https://www.researchgate.net/profile/Kenneth\\_Arrow/publication/5034990\\_Limited\\_network\\_connections\\_and\\_the\\_distribution\\_of\\_wages/links/00463523741cbc1421000000.pdf](https://www.researchgate.net/profile/Kenneth_Arrow/publication/5034990_Limited_network_connections_and_the_distribution_of_wages/links/00463523741cbc1421000000.pdf).
- Arrow, K.J., 1973. The Theory of Discrimination in Ashenfelter, Orley and Albert Rees (ed.) Discrimination in Labor Markets, Princeton University Press, 3–33.
- Barr, T., 2009. With friends like these: endogenous labor market segregation with homogeneous, nonprejudiced agents. *Am. J. Econ. Sociol.* 68 (3), 703–746.
- Barrera, D., Buskens, V., 2009. Third-party effects on trust in an embedded investment game. In: Cook, K., Snijders, C., Buskens, V., Cheshire, C. (Eds.), *eTrust: Forming Relationships in the Online World*. Russell Sage, New York.
- Barrera, D., van de Bunt, G.G., 2009. Learning to trust: networks effects through time. *Eur. Sociol. Rev.* 25 (6), 709–721. <http://dx.doi.org/10.1093/esr/jcn078>.
- Beaman, L., Magruder, J., 2012. Who gets the job referral? evidence from a social networks experiment. *Am. Econ. Rev.* 3574–3593.
- Beaman, L., Keleher, N., Magruder, J., 2013. Do Job Networks Disadvantage Women? Evidence from a Recruitment Experiment in Malawi. Department of Economics, Northwestern University (Working Paper).
- Berger, J., Rosenholtz, S.J., Zelditch, M., 1980. Status organizing processes. *Ann. Rev. Sociol.* 6, 479–508.
- Berninghaus, S., Erhart, K.M., Keser, C., 2002. Conventions and local interaction structures: experimental evidence. *Games Econ. Behav.* 39 (1), 177–205.
- Bertrand, M., Chugh, D., Mullainathan, S., 2005. Implicit discrimination. *Am. Econ. Rev.* 95 (2), 103–110.
- Bian, Y., Huang, X., Zhang, L., 2015. Information and favoritism: the network effect on wage income in China. *Social Networks* 40, 129–138.
- Bielby, W.T., Baron, J.N., 1986. Men and women at work: sex segregation and statistical discrimination. *Am. J. Sociol.* 91 (4), 759–799.
- Boero, R., Bravo, G., Castellani, M., Laganà, F., Squazzoni, F., 2009a. Pillars of trust: an experimental study on reputation and its effects. *Sociol. Res. Online* 14 (5) (URL <<http://www.socresonline.org.uk/14/5/5.html>>).
- Boero, R., Bravo, G., Castellani, M., Squazzoni, F., 2009b. Reputational cues in repeated trust games. *J. Socio-Econ.* 38, 871–877.
- Bohnet, I., 2009. Experiments. In: Hedström, P., Bearman, P. (Eds.), *The Oxford Handbook of Analytical Sociology*. Oxford University Press, pp. 639–665.
- Brashears, M.E., Gladstone, E., 2016. Error correction mechanisms in social networks can reduce accuracy and encourage innovation. *Social Networks* 44, 22–35.
- Brashears, M.E., Quintane, E., 2015. The microstructures of network recall: how social networks are encoded and represented in human memory. *Social Networks* 41, 113–126.
- Bravo, G., Squazzoni, F., Takács, K., 2015. Intermediaries in trust: indirect reciprocity, incentives, and norms. *J. Appl. Math.* 2015 (234528) (URL <<http://www.hindawi.com/journals/jam/aa/234528/>>).
- Brewer, M.B., 1979. In-Group bias in the minimal intergroup situation: a cognitive-Motivational analysis. *Psychol. Bull.* 86, 307–324.
- Brewer, M.B., 1996. In-Group favoritism: the subtle side of intergroup discrimination. In: Messick, D.M., Tenbrunsel, A.E. (Eds.), *Codes of Conduct. Behavioral Research into Business Ethics*. Russell Sage Foundation.
- Calvó-Armengol, A., Jackson, M.O., 2004. The effects of social networks on employment and inequality. *Am. Econ. Rev.* 94 (3), 426–454.
- Calvó-Armengol, A., Jackson, M.O., 2007. Networks in labor markets: wage and employment dynamics and inequality. *J. Econ. Theory* 132, 27–46.
- Camerer, C.F., 2003. Behavioral Game Theory. Princeton University Press, Princeton.
- Caria, A.S. and Hassen, I.W., 2013. The Formation of Job Referral Networks. Evidence from a Lab-in-the-Field Experiment in Urban Ethiopia. International Food Policy Research Institute (IFPRI) Discussion Paper, No. 1282.
- Chapin, F.S., 1932. The experimental approach I. the advantages of experimental sociology in the study of family group patterns. *Soc. Forces* 11, 200–207.
- Corten, R., 2009. Co-evolution of Social Networks and Behavior in Social Dilemmas Theoretical and Empirical Perspectives. ICS Dissertation Series, Utrecht.
- Darley, J.M., Fazio, R.H., 1980. Expectancy confirmation sequences. *Am. Psychol.* 35, 867–881.
- Denrell, J., Le Mens, G., 2011. Seeking positive experiences can produce illusory correlations. *Cognition* 119 (3), 313–324.
- Denrell, J., 2005. Why most people disapprove of me: experience sampling in impression formation. *Psychol. Rev.* 112, 951–978.
- DiMaggio, P., Garip, F., 2012. Network effects and social inequality. *Ann. Rev. Sociol.* 38, 93–118.
- Dovidio, J.F., Kawakami, K., Gaertner, S.L., 2002. Implicit and explicit prejudice and interracial interaction. *J. Pers. Soc. Psychol.* 82, 62–68.
- Elliott, J.R., 1999. Social isolation and labor market insulation: network and neighborhood effects on less-Educated urban workers. *Sociol. Quarterly* 40 (2), 199–216.
- Elliott, J.R., 2001. Referral hiring and ethnically homogeneous jobs: how prevalent is the connection and for whom? *Soc. Sci. Res.* 30, 401–425.
- Engström, P., Hesselius, P., Holmlund, B., 2012. Vacancy referrals, job search, and the duration of unemployment: a randomized experiment. *Labour* 26 (4), 419–435.
- Falk, A., Fehr, E., 2003. 'Why labor market experiments? *Labour Econ.* 10, 399–406.
- Falk, A., Heckman, J.J., 2009. Lab experiments are a major source of knowledge in the social sciences. *Science* 326, 535–538.
- Fehr, E., Gintis, H., 2007. Human motivation and social cooperation: experimental and analytical foundations. *Ann. Rev. Sociol.* 33, 43–64.
- Fernandez, R.M., Fernandez-Mateo, I., 2006. Networks, race, and hiring. *Am. Sociol. Rev.* 71, 42–71.
- Fernandez, R.M., Greenberg, J., 2013. Race, network hiring, and statistical discrimination. *Res. Sociol. Work* 24 (2013), 81–102.
- Fernandez, R.M., Castilla, E.J., Moore, P., 2000. Social capital at work: networks and employment at a phone center. *Am. J. Sociol.* 105 (5), 1288–1356.
- Fiedler, K., Juslin, P., 2006. Taking the interface between mind and environment seriously. In: Fiedler, K., Juslin, P. (Eds.), *Information Sampling and Adaptive Cognition*. Cambridge, University Press.
- Fischbacher, U., 2007. Z-Tree: zurich toolbox for ready-made economic experiments. *Exp. Econ.* 10, 171–178.
- Fiske, S.T., 2009. *Social Beings: Core Motives in Social Psychology*. Wiley, New York.
- Flache, A., Mäs, M., Feliciani, T., Chattoe-Brown, E., Deffuant, G., Huet, S., Lorenz, J., 2017. Models of social influence: towards the next frontiers. *J. Artificial Soc. Social Simulation* 20 (4), 2 <http://jasss.soc.surrey.ac.uk/20/4/2.html>.
- Fontaine, F., 2008. Why are similar workers paid differently? the role of social networks. *J. Econ. Dyn. Control* 32 (12), 3960–3977.
- Fountain, C., Stovel, K., 2014. Turbulent careers: social networks, employer hiring preferences, and job instability. In: Manzo, G. (Ed.), *Analytical Sociology*. pp. 339–370.
- Gërxhani, K., Brandts, J., Schram, A., 2013. The emergence of employer information networks in an experimental labor market. *Social Networks* 35, 541–560.
- Galton, F., 1907. *Vox populi (The wisdom of crowds)*. *Nature* 75 (7), 450–451.
- Gemkow, S., Neugart, M., 2011. Referral hiring, endogenous social networks, and inequality: an agent-Based analysis. *J. Evol. Econ.* 21, 703–719.
- Gilbert, D.T., Killingsworth, M., Eyre, R.N., Wilson, T.D., 2009. The surprising power of neighborly advice. *Science* 323 (5921), 1617–1619.
- Godechot, O., 2016. The chance of influence: a natural experiment on the role of social capital in faculty recruitment. *Social Networks* 46, 60–75.
- Granovetter, M., 1973. The strength of weak ties. *Am. J. Sociol.* 78, 1360–1380.
- Granovetter, M., 1974. *Getting a Job: A Study of Contacts and Careers*. University of Chicago Press, Chicago.
- Greiner, B., 2004. An online recruitment system for economic experiments. In: Kremer, K., Macho, V. (Eds.), *Forschung Und Wissenschaftliches Rechnen 2003. Ges. für Wiss. Datenverarbeitung, Göttingen*, pp. 79–93.
- Grogger, J., Ridgeway, G., 2006. Testing for racial profiling in traffic stops from behind a veil of darkness. *J. Am. Stat. Assoc.* 101 (475), 878–887.
- Hamilton, D.L. (Ed.), 1981. Erlbaum, Hillsdale, N.J.
- Hoeffler, S., Ariely, D., West, P., 2006. Path dependent preferences: the role of early experience and biased search in preference development. *Organ. Behav. Hum. Decis. Process.* 101, 215–229.
- Hofstra, B., Corten, R., Buskens, V., 2015. Learning in social networks: selecting profitable choices among alternatives of uncertain profitability in various networks. *Social Networks* 43, 100–112.
- Ioannides, Y.M., Loury, L.D., 2004. Job information networks, neighborhood effects, and inequality. *J. Econ. Lit.* 42, 1056–1093.
- Jackson, M., 2009. Disadvantaged through discrimination? the role of employers in social stratification. *Br. J. Sociol.* 60 (4), 669–692.
- Kaufman, R.L., 2002. Assessing alternative perspectives on race and sex employment segregation. *Am. Sociol. Rev.* 67 (4), 547–572.
- Kaufmann, M.C., Krings, F., Sczesny, S., 2015. Looking too old? how an older age appearance reduces chances of being hired. *Br. J. Manage.* 27 (4), 727–739.
- Keser, C., Erhart, K.M., Berninghaus, S.K., 1998. Coordination and local interaction: experimental evidence. *Econ. Lett.* 58, 269–275.
- Keuschnigg, M., Wolbring, T., 2015. The use of field experiments to study mechanisms of discrimination. *Anal. Kritik* 38 (1), 179–202.
- Kosfeld, M., 2004. Economic networks in the laboratory: a survey. *Rev. Network Econ.* 3 (1).
- Krauth, B.V., 2004. A dynamic model of job networking and social influences on employment. *J. Econ. Dyn. Control* 28 (6), 1185–1204.
- Kugler, A.D., 2003. Employee referrals and efficiency wages. *Labour Econ.* 10 (5), 531–556.
- Lane, T., 2016. Discrimination in the laboratory: a meta-Analysis of economics experiments. *Eur. Econ. Rev.* 90, 375–402.
- Le Mens, G., Denrell, J., 2011. Rational learning and information sampling: on the 'Naivety' assumption in sampling explanations of judgment biases. *Psychol. Rev.* 118 (2), 379–392.
- Lee, S., Pitesa, M., Pillutla, M., Thau, S., 2015. When beauty helps and when it hurts: an organizational context model of attractiveness discrimination in selection decisions. *Organ. Behav. Hum. Decis. Process.* 128 (May), 15–28.
- Lin, N., Ensel, W.M., Vaughn, J.C., 1981. Social resources and strength of ties: structural factors in occupational status attainment. *Am. Sociol. Rev.* 46, 393–405.
- Lorenz, J., Rauhut, H., Schweitzer, F., Helbing, D., 2011. How social influence can undermine the wisdom of crowd effect. *Proc. Natl. Acad. Sci.* 108 (22), 9020–9025.
- Marsden, P.V., Friedkin, N.E., 1993. Network studies of social influence. *Sociol. Methods Res.* 22 (1), 127–151.



- Mason, W., Watts, D.J., 2012. Collaborative learning in networks. *Proc. Natl. Acad. Sci.* 109 (3), 764–769.
- McBrier, D.B., 2003. Gender and career dynamics within a segmented professional labor market: the case of law academia. *Soc. Forces* 81 (4), 120–1266.
- McCall, J.J., 1970. Economics of information and job search. *Q. J. Econ.* 84 (1), 113–126.
- McDonald, S., 2011. What's in the old boys network? Accessing social capital in gendered and racialized networks. *Social Networks* 33 (4), 317–330.
- McPherson, M., Smith-Lovin, L., Cook, J.M., 2001. Birds of a feather: homophily in social networks. *Ann. Rev. Sociol.* 27, 415–444.
- Midtbøen, A.H., 2014. The context of employment discrimination: interpreting the findings of a field experiment. *Br. J. Sociol.*, 193–214, <http://dx.doi.org/10.1111/1468-4446.12098>.
- Model, S., 1993. The ethnic niche and the structure of opportunity: Immigrants and minorities in New York City. In: Katz, M. (Ed.), *The Underclass Debate: Views from History*. Princeton University Press, Princeton, pp. 161–193.
- Montgomery, J., 1991. Social networks and labor-market outcomes: toward an economic analysis. *Am. Econ. Rev.* 81, 1408–1418.
- Montgomery, J., 1992. Job search and network composition: implications of the strength of weak ties hypothesis. *Am. Sociol. Rev.* 57, 586–596.
- Mortensen, D., 1986. Job search and labor market analysis. In: Ashenfelter, O., Card, D. (Eds.), *The Handbook of Labor Economics* 2. (Amsterdam: North-Holland).
- Mouw, T., 2002. Racial differences in the effects of job contacts: conflicting evidence from cross-sectional and longitudinal data. *Soc. Sci. Res.* 31 (4), 511–538.
- Olian, J.D., Schwab, D.P., Haberfeld, Y., 1988. The impact of applicant gender compared to qualifications on hiring recommendations: a meta-analysis of experimental studies. *Organ. Behav. Hum. Decis. Process.* 41 (2), 180–195.
- Ostrom, E., 2010. Revising theory in light of experimental findings. *J. Econ. Behav. Organ.* 73 (1), 68–72.
- Pager, D., Bruce, W., Bonikowski, B., 2009. Discrimination in a low-Wage labor market: a field experiment. *Am. Sociol. Rev.* 74, 777–799.
- Petersen, T., Saporta, I., 2004. The opportunity structure for discrimination. *Am. J. Sociol.* 109, 852–901.
- Petersen, T., Saporta, I., Seidel, M.-D.L., 2000. Offering a job: meritocracy and social networks. *Am. J. Sociol.* 106, 763–816.
- Polman, E., 2010. Why are maximizers less happy than satisficers? because they maximize positive and negative outcomes. *J. Behav. Decis. Making* 23, 179–190.
- Ponzo, M., Scoppa, V., 2010. The use of informal networks in Italy: efficiency or favoritism? *J. Socio-Econ.* 39 (1), 89–99.
- Rogers, J.K., 2000. *Temps: The Many Faces of the Changing Workplace*. ILR Press.
- Rooth, D.O., 2010. 'Automatic associations and discrimination in hiring: real world evidence. *Labour Econ.* 17 (3), 523–534.
- Rosenbaum, J.E., Kariya, T., Settersten, R., Maier, T., 1990. Market and network theories of the transition from high school to work: their application to industrialized societies. *Ann. Rev. Sociol.* 16, 263–299.
- Roth, A.E., 1993. The early history of experimental economics. *J. Hist. Econ. Thought* 15, 184–209.
- Rubineau, B., Fernandez, R.M., 2013. Missing links: referrer behavior and job segregation. *Manage. Sci.* 59 (11), 2470–2489.
- Rubineau, B., Fernandez, R.M., 2015. How do labor market networks work? In: Robert Scott, A., Stephen Kosslyn, M. (Eds.), *Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource.*, pp. 1–15, <http://dx.doi.org/10.1002/9781118900772.etrds0168>.
- Simon, H., 1955. A behavioral model of rational choice. *Q. J. Econ.* 69, 99–118.
- Simon, H., 1956. Rational choice and the structure of the environment. *Psychol. Rev.* 63 (2), 129.
- Smith, V.L., 1991. *Papers in Experimental Economics*. Cambridge University Press.
- Smith, V.L., 2010. Theory and experiment: what are the questions? *J. Econ. Behav. Organ.* 73 (1), 3–15.
- Solnick, S.J., Schweitzer, M.E., 1999. The influence of physical attractiveness and gender on ultimatum game decisions. *Organ. Behav. Hum. Decis. Process.* 79 (3), 199–215.
- Sommerfeld, R.D., Krambeck, H.-J., Semman, D., Milinski, M., 2007. Gossip as an alternative for direct observation in games of indirect reciprocity. *Proc. Natl. Acad. Sci.* 104, 17435–17440.
- Spoonley, P., 2008. Utilising a demand-led approach in a local labor market. *Local Econ.: J. Local Econ. Policy Unit* 23 (1), 19–30.
- Stigler, G.J., 1961. The economics of information. *J. Political Econ.* 69 (3), 213–225.
- Stigler, G.J., 1962. Information in the labor market. *J. Political Econ.* 70 (5), 94–105.
- Stovel, K., Fountain, C., 2009. Matching. In: Hedström, P., Bearman, P. (Eds.), *The Oxford Handbook of Analytical Sociology*. Oxford University Press.
- Surowiecki, J., 2005. *The Wisdom of Crowds*. Anchor.
- Takács, K., Squazzoni, F., 2015. High standards enhance inequality in idealized labor markets. *J. Artif. Soc. Social Simul.* 18 (4), 2 <http://jasss.soc.surrey.ac.uk/18/4/2.html>.
- Takács, K., Squazzoni, F., Bravo, G., Castellani, M., 2015. Employer networks, priming, and discrimination in hiring: an experiment. In: Manzo, G. (Ed.), *Analytical Sociology*. Wiley and Sons, Chichester.
- Takács, K., Flache, A., Mäs, M., 2016. Discrepancy and disliking do not induce negative opinion shifts. *PLoS One* 11 (6), e0157948.
- Tassier, T., Menczer, F., 2008. Social network structure, segregation, and equality in a labor market with referral hiring. *J. Econ. Behav. Organ.* 66, 514–528.
- Tian, F.F., Liu, H., 2018. Gendered double embeddedness: finding jobs through networks in the chinese labor market. *Social Networks* 52, 28–36.
- Tilly, C., 1998. *Durable Inequality*. University of California Press, Berkeley.
- Uhlmann, E.L., Cohen, G.L., 2007. I think it, therefore it's true: effects of self-perceived objectivity on hiring discrimination. *Organ. Behav. Hum. Decis. Process.* 104 (2), 207–223.
- Ule, A., 2008. Partner choice and cooperation in networks. theory and experimental evidence. *Lecture Notes in Economics and Mathematical Systems*, vol. 598. Springer.
- Uzzi, B., 1996. The sources and consequences of embeddedness for the economic performance of organizations: the network effect. *Am. Sociol. Rev.* 61 (4), 674–698.
- Webster, M., Sell, J., 2007. *Laboratory Experiments in the Social Sciences*. Academic Press.
- Wegener, B., 1991. Job mobility and social ties: social resources, prior job, and status attainment. *Am. Sociol. Rev.* 56, 60–71.
- Willer, D., Walker, H., 2007. *Building Experiments: Testing Social Theory*. Stanford University Press, Stanford.
- Wilson, W.J., 1987. *The Truly Disadvantaged*. University of Chicago Press, Chicago, IL.
- Zschornt, E., Ruedin, D., 2016. Ethnic discrimination in hiring decisions: a meta-analysis of correspondence tests. *J. Ethnic Migration Stud.* 42 (7), 1115–1134.