

## ## WHAT IS IT?

This is the implementation of the model that is reported in the submission "High Standards Enhance Inequality in Idealized Labor Markets" to JASSS by Károly Takács and Flaminio Squazzoni.

This agent-based model aims to demonstrate that searching for the best options in the dual or one-sided matching process (dualmatching) in the labor market does not result in efficient and fair outcomes, as many economists believe. The model allows for the analysis of the consequences of purposeful selection choices of employers and acceptance decisions of applicants in a labor market with asymmetric information.

## ## HOW IT WORKS

This is a model of a simplified job market with unemployment, in which a fixed number of employers ( $n$ -employers) select employees ( $n$ -workers) for a restricted number of jobs (to-fill each). Workers can accept or reject job offers. Employers hire workers for a fixed contract period of one year, during which the contract cannot be broken. Both employees and employers have an internal quality taken from a uniform random distribution with possible integer values of  $\{0, 1, \dots, 19\}$ . We assume that individual quality is fixed over time and does not improve by experience. We consider one recognizable trait for workers (color) and two social categories of this trait (blues and greens) with a fixed category membership.

While workers vary in their quality, characteristics of this variation are independent of color. Therefore, there is no statistical basis for discrimination. We assume that all employers are perfectly neutral: they do not belong to any of the workers' social categories and do not have any initial bias towards them. We consider asymmetric information in the sense that employers are unable to observe the true individual quality of workers until they hire them, only their social category. Each employer forms reputations about the two groups based on private experience with workers (blues, greens). Group reputations for each employer are calculated as the mean quality of the workers hired from that category in the previous  $m$  periods.

Selection and acceptance decisions are based on (aspiration- $i$ ) of employers (taken from the distribution specified in the interface by (aspiration-levels)); and on (aspiration) of workers.

We assume that individual aspiration levels are fixed over time.

We consider a two-sided matching protocol in which employers give priority to previous workers whom they are satisfied with, i.e., to workers with a quality equal to or above (aspiration- $i$ ) and above (blues) and (greens). Employers do not re-hire anyone below these thresholds, because they rationally expect that a random worker has a higher quality than their current employee. If a selected worker has not worked there before, the contract is accepted automatically. If she worked there before, we assume she rejects the proposal if the firm's (quality) is below her (aspiration).

Hiring into job positions takes place sequentially. For each hiring, first, the selected employer checks previous employees and re-hires the one with the highest quality who is available, in case her quality is not below (aspiration- $i$ ) and is higher than (blues) and (greens). Re-hiring takes place only when the firm's (quality) is equal to, or higher than the (aspiration) of the worker. Otherwise, the worker rejects the offer. Second, if there is no previous employee who satisfies the previous condition, an unemployed worker is picked randomly from a group with higher reputation. If group reputations are equal (e.g., at the outset), then an unemployed worker is randomly selected. The procedure is repeated until all vacancies are filled.

The quality of employees is remembered by the employer from the last employment until (max-link-age) periods, irrespectively of the employee's quality. For the sake of simplicity, we assume that the memory parameter (max-link-age) is the same for all employers. It is worth outlining that memory limitation is an assumption that prevents the system from running into a market with full information.

In addition, reputation mechanisms can be chosen using the (group-gossip), (top-bias) and (bottom-bias) variables. (group-gossip) modifies group reputation by the (blues) and (greens) of (professional ties). (group-gossip) describes the proportion to which group-reputation of friends determine the group-reputation of the given agent.

The (top-bias) and the (bottom-bias) variables have been introduced to capture cognitive biases. Their sum is a maximum of 1. A value of 1 for (top-bias) means that agents have a cognitive bias in creating their own group-reputation: they base this simply on the highest quality worker known from the given category. A value of 1 for (bottom-bias) means that agents have a cognitive bias in creating their own group-reputation: they base this simply on the lowest quality worker known from the given category. If both of them are 0, then there is no cognitive bias: agents take into account the mean values. The mean value is taken into consideration with a weight of  $1 - (\text{top-bias}) - (\text{bottom-bias})$ .

If a worker is hired by an employer, she is unavailable to any other job. This means that in our model, there are externalities of selection choices. As a consequence, a shortage of high quality workers can quickly take place in the labor market.

## ## HOW TO USE IT

Use the interface to set up values of the major parameters. Push (setup) to initialize the network according to (network-type). Click on go to start one simulation. Use the behavioral space option to generate multiple simulation runs.

As dependent measures, observe (average-discrimination), (adjusted-discrimination), (ave-mean-discrimination), (mean-discrimination), (labormarketsegregation-index) (variance-discrimination), (ave-var-discrimination), (new-disc-index), (pairwise similarity), (average-correlation-index), (correlation-index), (average-correlation-index2), (correlation-index2), and the plots of (Number of hired workers), (Group reputation), (Correlation empl-quality worker-aspiration) = (correlation-index), and (Correlation empl-quality worker-quality) = (correlation-index2).

The macro level discrimination (average-discrimination) is the objective extent to which members from different groups are hired disproportionately. (average-discrimination) is distinguished from micro level discrimination (ave-mean-discrimination), which is the average extent to which individual employers stock up employees from the same group. The index is 0 in case of no inequalities in employment, and 1 when each job is filled with workers belonging to the same category. The micro level discrimination index (ave-mean-discrimination) is calculated similarly as the macro level index for each individual employer and then averaged over all employers.

The concentration of assertive workers in better jobs is measured by the Pearson correlation of obtained firm's quality and assertiveness. Similarly, we used this measure to describe the concentration of good workers in good jobs.

## ## THINGS TO NOTICE

The model demonstrates that inefficiency and inequality are inevitable consequences of seemingly optimizing behavior in the labor market.

Notice the high level of discrimination indexes for any starting value.

Considering two groups of employees, our results show that inequality in employment always emerges due to the limited supply of high quality individuals, even in situations where there is no objective quality difference between average qualities and hiring decisions are not biased in favor of any of the groups. Inequalities are more exacerbated when employers have higher aspirations than if they do not strive for the best workers. We also found that assertive workers get higher quality jobs even if assertiveness is not correlated or even negatively correlated with internal quality. Our findings help to corroborate empirical findings that find higher employment discrepancy in high status jobs.

## ## THINGS TO TRY

One could assume that employers have heterogeneous (aspiration-levels). We did not find any qualitative difference in the results if we relaxed the assumption of homogeneity. Among the control variables, (max-link-age) had a remarkable effect both on discrimination and on the correlation of assertiveness and firm's quality. Longer memory enlarged the available pool of information and decreased discrimination, but it increased the extent of the assertiveness trap under any aspiration level and initial correlation of assertiveness and worker quality.

## ## EXTENDING THE MODEL

In addition to the parameters reported in the manuscript, this version introduces different reputation mechanisms.

## ## RELATED MODELS

Abdou M, Gilbert N (2009) Modelling the Emergence and Dynamics of Social and Workplace Segregation. *Mind Society* 8: 173-191.

Guerrero OA, Axtell RL (2013) Employment Growth through Labor Flow Networks. *PLoS ONE* 8(5): e60808. doi:10.1371/journal.pone.0060808

Stovel K, Fountain C (2009) Matching. In: Hedström, Peter and Bearman, Peter (eds.): *The Oxford Handbook of Analytical Sociology*. Oxford University Press.

## ## CREDITS AND REFERENCES

The code is written by Károly Takács. quality workers can quickly take place in the labor market.