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Social network formation and labor market inequality☆

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HIGHLIGHTS

- We study network formation in the labor market.
- Workers differ in interpersonal skills which creates inequality among workers.
- We show that inequality is larger in equilibrium than in social optimal allocation.
- Individuals with high(low) interpersonal skills over(under)invest in link formation.
- Largest inequality is arises when job availability is moderate.

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ABSTRACT

We study how differences in interpersonal skills lead to inequality among workers when social connections are endogenously formed and workers find jobs through their contacts. We show that the equilibrium network structure is very unequal in terms of links and access to jobs. The equilibrium network is not socially optimal because workers impose negative externality on each other by forming more links. The degree of inequality is larger in the equilibrium than what would be socially optimal. In the equilibrium, high-skilled individuals overinvest in networking while low-skilled individuals underinvest, which enlarges the impact of differences in interpersonal skills. The degree of inequality is largest when job availability is moderate.

1. Introduction

Many recent studies show that social contacts play a significant role in job search, see e.g. Granovetter, 1995, Bentolila et al., 2010 and Franzen and Hangartner, 2006. Inequality in access to social connections is known to generate inequality in employment rates and wages (Ioannides and Soetevent, 2006; Arrow and Borzekowski, 2004; Igarashi, 2016). Differences in personal characteristics, such as interpersonal skills or non-cognitive skills, may well be one of the factors that generate inequality in access to social contacts and job referrals. One interesting question is what level of inequality is generated by the network formation process when workers differ in personal characteristics and whether the level of inequality is socially optimal. In this regard, (Galenianos, 2016) finds that inequality is larger in equilibrium than the socially optimal level when workers substantially differ in productivity.

In this paper, we study how differences in interpersonal skills generate inequality in the labor market through the network formation process and compare the resulting degree of inequality to the socially optimal level.[1] In addition, we analyze how the level of inequality depends on the labor market conditions such as the availability of jobs.

We find that individuals with better interpersonal skills overinvest in networking while others with worse skills underinvest. In

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[1] Non-cognitive skills have been acknowledged to play important role in producing differential of labor market outcomes, see Bowles et al., 2001, Heckman et al., 2006 and Fletcher, 2013.

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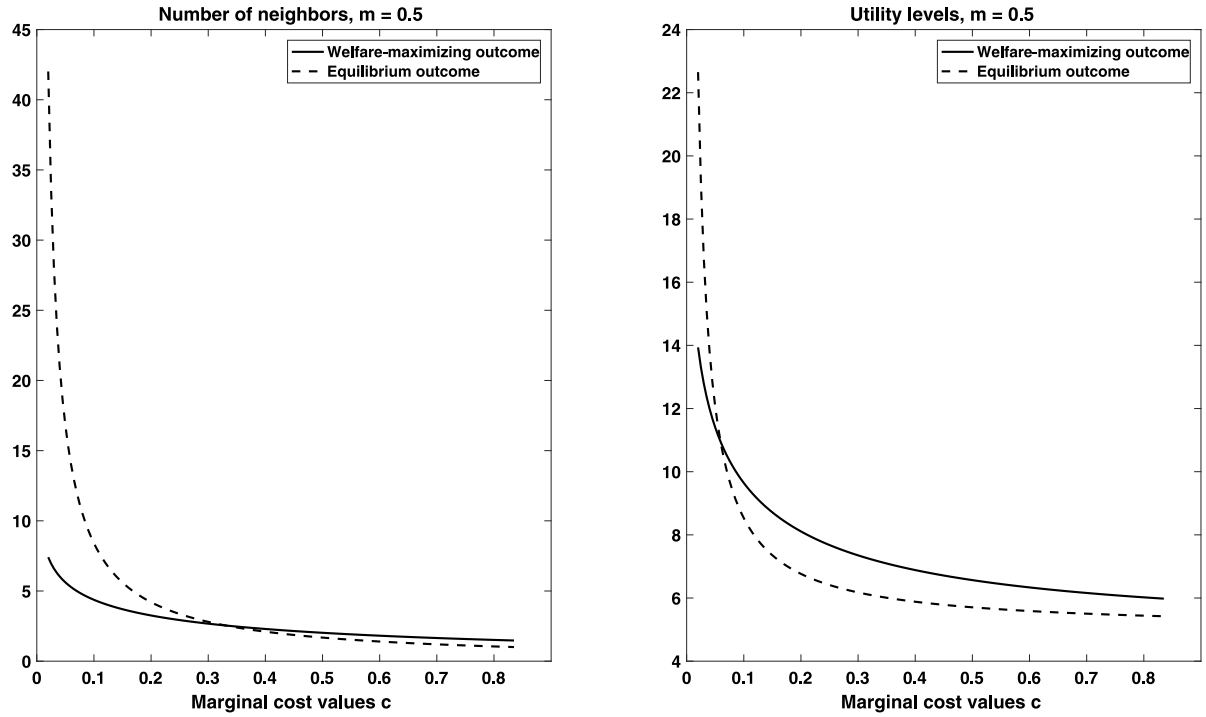

Fig. 1. Number of links (left), utility levels (right) as function of marginal cost parameter c. Solid line: socially optimal allocation, dashed line: decentralized equilibrium.

the equilibrium, the degree of inequality is larger than the socially optimal level due to a negative externality present in the network formation process. We show that this problem is especially severe when job availability is moderate because this is the case when workers rely the most on social networks for job search.

2. Model

2.1. Decentralized equilibrium

We assume that workers are heterogeneous with respect to interpersonal skills, which we represent by the cost of social networking. The cost of forming/maintaining a link is a quadratic function of the number of links n_i: $C_i(n_i) = \frac{1}{2}c_i n_i^2$ where the marginal cost parameter c_i is uniformly distributed in the population: $c_i \sim U[\underline{c}, \bar{c}]$ where $\underline{c} > 0$.[2] To simplify analytical calculations, we assume that the largest cost type ($\bar{c}$) forms the minimum number of links in equilibrium, that is, 1.[3]

We consider a simple labor market where the vacancy rate $p \in (0, 1)$, the probability of being unemployed $\delta \in (0, 1)$ and wages $w > 1$ are fixed parameters (similarly to the analytical model in Galeotti and Merlino, 2014). This not only facilitates deriving an analytical solution, but also allows us to focus on the interactions originating exclusively from link formation. Further, we assume that job information can be obtained either through the labor market or through employed friends. If an employed worker has information about a vacancy, she shares it with a random unemployed neighbor of hers (Calvó-Armengol and Zenou, 2005).

An individual may form any number of links $n_i \in [1, N]$ where N is the population size, assumed to be finite and large. For analytical simplicity, we treat the number of neighbors n_i as a continuous variable. The probability density function of the resulting degree distribution is denoted by $g(t)$. Given the individual choices of number of links, the social network is randomly generated by the configurations model (Vega-Redondo, 2007; Jackson, 2010). The average degree of the network is $E[k] = \int_1^N tg(t)dt$. The probability density function of a neighboring node's degree is $\tilde{g}(t) = \frac{tg(t)}{E[k]}$ (Vega-Redondo, 2007).

Given these assumptions, the probability that someone with n_i links obtains job information through her social contacts is:

$$q(n_i) = pn_i(1-\delta)\int_1^N \left(\frac{1-(1-\delta)^t}{\delta t}\right)\frac{tg(t)}{E[k]}dt = \frac{pn_i(1-\delta)}{\delta E[k]}\int_1^N (1-(1-\delta)^t)g(t)dt = \frac{pn_i(1-\delta)}{\delta E[k]}E[1-(1-\delta)^k] \quad (1)$$

where p is the probability that a contact knows about job information, and $n_i(1-\delta)$ is the number of employed social contacts. The remaining part of the formula calculates the probability of hearing of a job offer from a given social contact. This depends on the number of links this contact has and the probability that each link leads to an unemployed worker, who is a competitor for the job information (see Calvó-Armengol and Zenou, 2005 for similar derivations).

An unemployed worker hears about a job offer either through the formal labor market with probability p, or through her social contacts. The expected utility of individual i with n_i links depends on the benefits of finding a job and the link formation cost:

$$U_i(n_i) = [p + (1-p)q(n_i)]\,w - \frac{1}{2}c_i n_i^2 = \left[p + (1-p)\frac{pn_i(1-\delta)}{\delta E[k]}E[1-(1-\delta)^k]\right]w - \frac{1}{2}c_i n_i^2 \quad (2)$$

Individuals maximize utility to obtain the optimal number of neighbors, which can be solved as:

$$n_i^*(c_i) = \frac{(1-\delta)}{c_i\delta E[k]}E[1-(1-\delta)^k]wp(1-p) \quad (3)$$

[2] In the Appendix A we show results for the normal cost distribution as well.

[3] We performed robustness checks regarding this assumption, our numerical analysis shows that it is non-essential regarding the results.

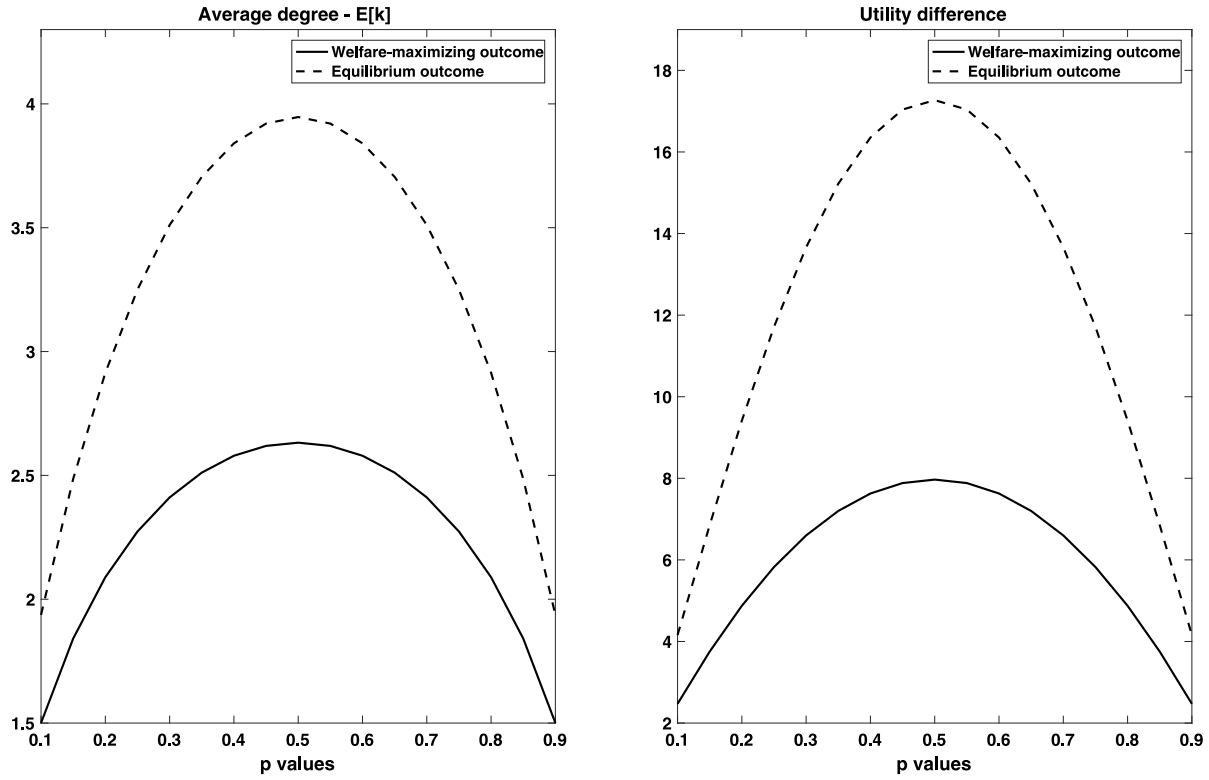

Fig. 2. Impact of vacancy rate p. The right (left) panel represents the utility difference $U(\underline{c}) - U(\bar{c})$ ($E[k]$) in equilibrium (dashed line) and the socially optimal allocation (solid line).

The number of links formed decreases with the linking cost and the average degree.[4] When $E[k]$ is large, social networking is less beneficial, because an individual can connect to others linked to many other contacts who all compete for the same job information. This competition generates a negative externality among workers.

In the Web Appendix, we show that for the uniform marginal cost distribution, the resulting degree distribution is power law with exponent 2, which is a very unequal distribution. Power law degree distributions with exponents between 2 and 3 have been observed in many social networks (Newman, 2003; Aiello et al., 2002; Ebel et al., 2002). Our model explains this phenomenon in a labor market context.

2.2. Socially optimal outcome

We turn to the social planner's problem who maximizes the joint welfare of all workers and we derive the conditions that determine the degree distribution in this case. The aggregate welfare is given by:

$$\begin{aligned}&\int_{\underline{c}}^{\bar{c}} U(n(c))f(c)dc\\ &= \int_{\underline{c}}^{\bar{c}} \left(\left[p + p(1-p)\frac{n(c)(1-\delta)}{\delta E[k]}E[1-(1-\delta)^k]\right]w\right.\\ &\left. - \frac{1}{2}cn(c)^2\right)f(c)dc =\\ &pw + p(1-p)\frac{(1-\delta)}{\delta}w\int_{\underline{c}}^{\bar{c}}\left(1-(1-\delta)^{n(c)}\right)f(c)dc\\ &- \int_{\underline{c}}^{\bar{c}}\frac{1}{2}cn(c)^2f(c)dc\end{aligned}$$

[4] We compute the expectations $E[k]$ and $E[1-(1-\delta)^k]$ in the Web Appendix, see Lemma 1.

Aggregate welfare can be maximized if all job offers are matched to unemployed workers who start to produce w. This is equivalent to the situation that the social planner chooses the number of links to maximize the probability that job offers possessed by employed workers can be forwarded to unemployed contacts. This is ensured if they have at least one unemployed contact which occurs with probability $1-(1-\delta)^{n(c)}$.

The first-order condition of the social planner's problem is:

$$B(1-\delta)^{n(c)} = cn(c) \tag{4}$$

where $B = -p(1-p)(1-\delta)w\ln(1-\delta)/\delta$. This equation defines an optimal number of links for each value of marginal cost parameter c, which we denote by $n_i^{SO}(c_i)$.

3. Results

3.1. Decentralized equilibrium vs. social optimum

Our first result shows that low-cost individuals overinvest in networking in equilibrium relative to the social optimal level, while high-cost individuals underinvest. For low-cost types it is easy to form a large number of links. This decreases the incentives for high-cost types to form connections, since by adding links they will connect to others with many links who are less likely to pass a job offer due to the high competition for job information. This negative externality enlarges the inequality originating from the heterogeneity of link formation costs. The social planner corrects this externality and allocates less (more) links to low-cost (high-cost) individuals. The level of inequality in links is lower in the social optimum than in the equilibrium.

Proposition 1. *There exists a cutoff value c^* such that if $c_i \le c^*$, then $n_i^*(c_i) \ge n_i^{SO}(c_i)$ and if $c_i > c^*$, then $n_i^*(c_i) < n_i^{SO}(c_i)$.*

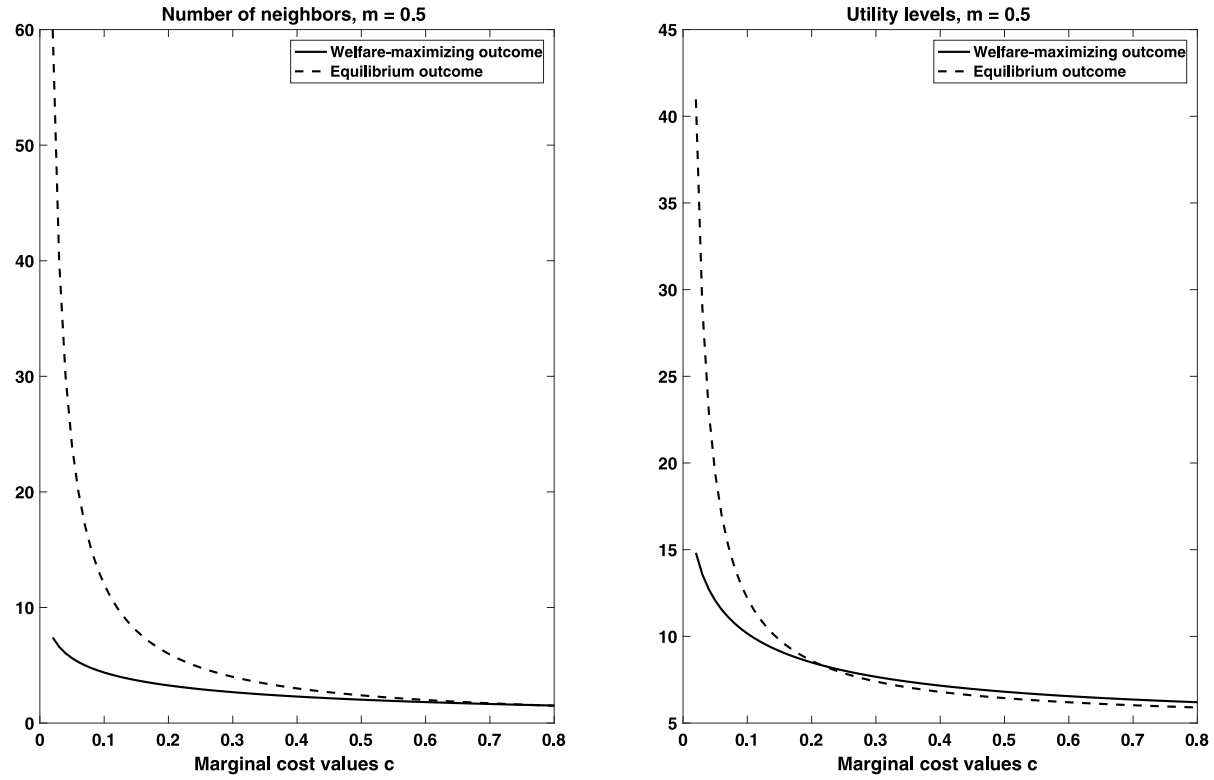

Fig. 3. Number of links (left) and utility levels (right) as function of marginal cost parameter c, assuming normal cost distribution: $c_i \sim N(0.5, 0.15)$. Solid line: socially optimal allocation, Dashed line: decentralized equilibrium.

Proof. See Web Appendix. □

We study the implications of Proposition 1 for the utility levels numerically. We set $w = 10$, $\delta = 0.3$, $p = 0.5$, $\underline{c} = 0.02$ and $\bar{c} = 0.84$ so that $n_i^*(\bar{c}) = 1$. Fig. 1 shows that low-cost (high-cost) individuals obtain larger (smaller) utility in the equilibrium than in the socially optimal allocation. Inequality in welfare is larger in the equilibrium than what would be socially optimal.[5]

3.2. The impact of labor market conditions

We analyze how the labor market conditions, especially the availability of jobs affects the social network formed and the level of inequality in equilibrium. When jobs are plentiful, individuals have no incentives to form social connections since the labor market can provide job offers. When jobs are scarce, the probability that others have job information is low, so networking is again not beneficial. The highest networking activity arises when the availability of jobs is moderate (Galeotti and Merlino, 2014; Schmutte, 2016). Since inequality is introduced by differences in social connections, the degree of inequality is largest when networks are the most important for job finding, that is, when job availability is moderate. We measure the degree of inequality by the utility difference between two individuals with different linking cost levels. We have the following result.

Proposition 2. *In the equilibrium, the average degree of the network is maximal when $p = 0.5$ and the degree of inequality is maximal when $p = 0.5$.*

Proof. See Web Appendix. □

[5] Our results are robust to changes in the parameters, simulations are available from the authors. In the Appendix A, we show the results for normally distributed cost types as robustness check.

We illustrate this result in Fig. 2: the average degree and the level of inequality follow a non-monotonic function in the vacancy rate p and reach a peak at $p = 0.5$. Note that the same seems to hold in the social optimum, while average degree and inequality is larger in equilibrium than in the socially optimal allocation.

4. Conclusion

Our paper shows that differences in interpersonal skills can lead to substantial inequality in the labor market through job finding via social contacts. When individuals choose the number of their connections, the resulting social network is not socially optimal and the degree of inequality is larger in equilibrium than what would be socially optimal. Inequality is most severe when the number of available jobs is moderate. Our results suggest that labor market policies can effectively decrease the level of inequality if they focus on enhancing the efficiency of formal job search methods. Since workers substitute one search method for another (Merlino, 2014), more efficient formal methods will lead to less reliance on social contacts and a lower degree of inequality. While governments often support job search during recessions, our results show that such policies can be important for reducing inequality when job availability is moderate.

Appendix A. Results for normal type distribution

See Figs. 3 and 4.

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econlet.2018.01.026.

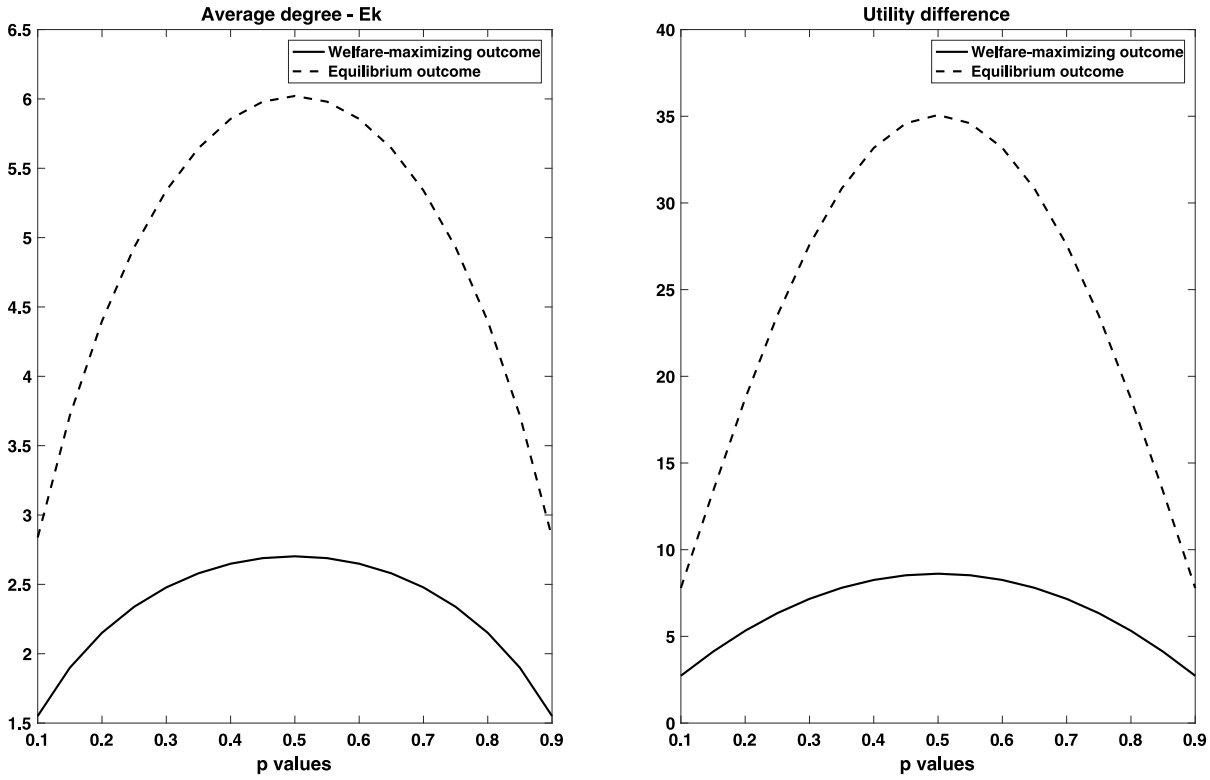

Fig. 4. Impact of vacancy rate p, assuming normal cost distribution: $c_i \sim N(0.5, 0.15)$. The right (left) panel represents the utility difference $U(\underline{c}) - U(\bar{c})\,(E[k])$ in equilibrium (dashed line) and the socially optimal allocation (solid line).

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