A Social Network Analysis of Occupational Segregation

Sebastian Buhai and Marco van der Leij

Northwestern University and Aarhus University
University of Alicante and Cambridge University

Outline

- **Introduction**
- Model
- Main results
- Simulation
- Conclusion

Introduction

Differentials in wages, employment participation, and unemployment between races and genders. e.g. Altonji and Blank (1999:

	Unemployment rate	Annual earnings
White males	4.3 %	42,742
Black males	10.3 %	29,651
White females	2.8 %	27,583
Black females	5.9 %	22,871

Most theories trying to explain these differences are based on the assumption that there is *discrimination* in the labor market.

Introduction

Kenneth Arrow (1998):

[**?**,]'[. . .] black and white wages for the same job very frequently differed, but little. Discrimination mainly took the form of limiting the range of jobs in which blacks were hired at all. [. . .] we have very strong evidence that these practices persist in some important measure. [. . .] market-based explanations will tend to predict that racial discrimination will be eliminated. Since they are not, we must seek elsewhere for non-market factors influencing economic behavior. The concepts of direct social interaction and networks seem to be good places to start."

Preview

We present a simple social network model, a variant of Benabou (1993), in which occupational segregation is a natural outcome. We ask the following questions:

- Does this model exhibit typical patterns of wage and employment inequality?
- Why do agents choose a job that gives a lower wage and in which the unemployment rate is higher?
- Would a socially optimal policy be a policy of integration?

Findings

Our theoretical analysis and the simulations show that:

- in equilibrium there is occupational segregation;
- one group specializes in the best job and this group enjoys higher employment and also (possibly) higher wages;
- calibration of the parameters and simulations suggest a wage gap up to 30%;
- A first- and second-best social optimum involves *segregation*. This differs from Benabou (1993).

Related Literature

- Wage gaps and discrimination: Altonji & Blank (1999), Petersen & Morgan (1995) etc
- Segregation: Schelling (1971), Benabou (1993); Padavic and Reskin(2002), Charles and Grusky (2004), Sorensen (2004)
- Networks and Labour Markets: Granovetter (1995), Calvó & Jackson (2004), Calvó & Zenou (2005), Ioannides & Soetevent (2006) etc etc
- Network Formation and Homophily: Currarini, Jackson & Pin (2007); de Marti & Zenou (2008); Marsden (1987), Montgomery(1992), Fernandez and Sosa (2005), Mayer and Puller (2008)

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Model

Agents are identical except for their "social colour", Red and Green. There are two occupations A and B.

Four stages

1. Agents choose specific education (career) A or B.
2. Agents form a job contact network.
3. Agents search for a job.
4. Agents receive wages and consume.

Education choice

Agents choose rationally choose a *specific* education A or B. Let $\mu_R \in [0, 1]$ be the measure of Red workers that choose education A. μ_G is the measure of Green workers choosing A. Then in a Nash equilibrium:

$$\Delta\Pi^X(\mu_R, \mu_G) \leq 0 \text{ if } \mu_X = 0 \quad (1)$$

$$\Delta\Pi^X(\mu_R, \mu_G) = 0 \text{ if } 0 < \mu_X < 1 \quad (2)$$

$$\Delta\Pi^X(\mu_R, \mu_G) \geq 0 \text{ if } \mu_X = 1. \quad (3)$$

Restriction to stable equilibria (stability concept based on standard myopic adjustment of strategies, taking place before the education decision is made).

Network formation

After education choice: formation of job contacts. We assume that the formation is exogenous, and random with *inbreeding homophily*

		Education	
		same	different
Social group	same	$p + \kappa + \lambda$	$p + \lambda$
	different	$p + \kappa$	p

Labour market: Job search (Initially unemployed) workers search for jobs, directly, and indirectly through friends. Employment rate: $s_i = s(x_i)$, where x_i is the measure of friends with the *same education* as i. s_i is *increasing in the number of friends with the same education.*

The employment rate s_A^X and s_B^X of A(B)-workers in group X

$$s_A^X(\mu_R, \mu_G) = s\left((p+\kappa)\bar{\mu} + \lambda\mu_X/2\right) \quad (4)$$

$$s_B^X(\mu_R, \mu_G) = s\left((p+\kappa)(1-\bar{\mu}) + \lambda(1-\mu_X)/2\right) \quad (5)$$

where $\bar{\mu} \equiv (\mu_R + \mu_G)/2$.

Labour market: Wage setting

As in Benabou (1993), consumption, prices, utility, demand for labor and implied wages determined in a 1-good, 2-factor general equilibrium model.

Effective labour supply:

$$L_A(\mu_R, \mu_G) = \mu_R s_A^R(\mu_R, \mu_G)/2 + \mu_G s_A^G(\mu_R, \mu_G)/2 \tag{6}$$

and

$$L_B(\mu_R, \mu_G) = (1 - \mu_R) s_B^R(\mu_R, \mu_G)/2 + (1 - \mu_G) s_B^G(\mu_R, \mu_G)/2. \tag{7}$$

Production function $F(L_A, L_B)$, strictly increasing and strictly concave in both L_A and L_B. Employed workers obtain wage $w_A(\mu_R, \mu_G)$ or $w_B(\mu_R, \mu_G)$.

Ex-ante payoffs

Workers' utility $U(w_A)$ or $U(w_B)$ is increasing and concave in wage. Unemployed workers obtain utility $U(0) = 0$.

We can now define the payoff of a worker as her expected utility at the time of decision-making. The payoff function of an A-educated worker from social group $X \in \{R, G\}$ is thus

$$\Pi_A^X(\mu_R, \mu_G) = s_A^X(\mu_R, \mu_G) U(w_A(\mu_R, \mu_G)). \tag{8}$$

Similarly,

$$\Pi_B^X(\mu_R, \mu_G) = s_B^X(\mu_R, \mu_G) U(w_B(\mu_R, \mu_G)). \tag{9}$$

We make two non-restrictive assumptions to guarantee unique equilibrium (actually: two symmetric equilibria).

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Equilibrium results

Define segregation

- There is *complete segregation* if *both groups* specialize: $\mu_R = 0$ and $\mu_G = 1$, or $\mu_R = 1$ and $\mu_G = 0$.
- There is *partial segregation* if *one group* specializes and the other mixes: for $X \in \{R, G\}$ and $Y \in \{R, G\}$, $Y \neq X$: $\mu_X = 0$ but $\mu_Y < 1$, or $\mu_X = 1$ but $\mu_Y > 0$.
- Without loss of generality we further assume $w_A(1,0) \geq w_B(1,0)$, thus that the A-occupation is weakly more attractive than the B-occupation when effective labor supply is equal.

Results 1: Occupational segregation

There are exactly two symmetric equilibria involving complete or partial *occupational segregation*. Define $s_H \equiv s((p+\kappa+\lambda)/2)$ and $s_L \equiv s((p+\kappa)/2)$.

If

$$1 \leq \frac{U(w_A(1,0))}{U(w_B(1,0))} \leq \frac{s_H}{s_L} \tag{10}$$

then there are exactly two stable equilibria, both with complete segregation. If

$$\frac{U(w_A(1,0))}{U(w_B(1,0))} > \frac{s_H}{s_L} \tag{11}$$

then there are exactly two stable equilibria, both with partial segregation, in which either $\mu_R = 1$ or $\mu_G = 1$.

Results 1: Occupational segregation

- Non-segregation cannot obtain. Positive homophily creates a group-dependent network effect, similar to Schelling's model of local interaction.
- If the wage differential between the two jobs (for equal numbers of A-educated and B-educated workers) is not "too large" vis-à-vis the social network effect, complete segregation is the only stable equilibrium outcome.
- Starting from complete segregation, a "large" wage differential gives incentives to the group specialized in B-jobs to switch to A-jobs. We obtain a partial equilibrium, in which one group specializes in the "good" job A, while the other one mixes.

Results 2: Inequality outcomes

- Consider the case in which wage differentials are small enough so that complete segregation is an equilibrium, ($\mu_R = 1$ and $\mu_G = 0$). Then, there is *equal employment*, but one group earns a higher wage.

$$w_A \geq w_B,$$

$$s_A^R = s_B^G > s_B^R = s_A^G,$$

and

$$\Pi_A^R \geq \Pi_B^G \geq \Pi_A^G \geq \Pi_B^R. \tag{12}$$

- Somewhat interestingly, if some workers make mistakes in their education choice, then the workers that are the worst off are from the same social group as the workers that are the best off.

Results 2: Inequality outcomes

- If wage differentials are large, there is a partial equilibrium in which $(\mu_R, \mu_G) = (1, \mu^*)$ where $\mu^* \in (0, 1)$,

$$\Pi_A^G(1, \mu^*) = \Pi_B^G(1, \mu^*),$$

  or equivalently

$$s_A^G(1, \mu^*) U(w_A(1, \mu^*)) = s_B^G(1, \mu^*) U(w_B(1, \mu^*)).$$

- Hence, whereas workers in group R prefer the A-job, the workers in group G make an individual trade-off: lower wages should be exactly compensated by higher employment probabilities and vice versa.

Results 2: Inequality outcomes

- Define $\hat{\mu} \in (0, 1)$, such that

$$w_A(1, \hat{\mu}) = w_B(1, \hat{\mu}), \tag{13}$$

and let $(\mu_R, \mu_G) = (1, \mu^*)$ be a stable equilibrium. In that equilibrium

$$\Pi_A^X > \Pi_B^Y = \Pi_A^Y > \Pi_B^X. \tag{14}$$

Results 2: Inequality outcomes

(i) if $\hat{\mu} < \frac{\lambda}{2(p+\kappa+\lambda)}$, then

$$s_A^R > s_B^G > s_A^G > s_B^R,$$

and

$$w_A(1, \mu^*) > w_B(1, \mu^*);$$

(ii) if $\hat{\mu} > \frac{\lambda}{2(p+\kappa+\lambda)}$, then

$$s_A^R > s_A^G > s_B^G > s_B^R,$$

and

$$w_B(1, \mu^*) > w_A(1, \mu^*).$$

Results 3: Social welfare, first best

We consider a utilitarian welfare function.

$$W(\mu_R, \mu_G) = \mu_R \Pi_A^R/2 + (1-\mu_R)\Pi_B^R/2 + \mu_G \Pi_A^G/2 + (1-\mu_G)\Pi \tag{15}$$

which, given unemployed workers get zero utility, can also be written

$$W(\mu_R, \mu_G) = L_A U\left(\frac{\partial F}{\partial L_A}(L_A, L_B)\right) + L_B U\left(\frac{\partial F}{\partial L_B}(L_A, L_B)\right), \tag{16}$$

Social optimum $\mu^S = (\mu_R^S, \mu_G^S)$ is defined as

$$\mu^S = \text{argmax}_{\mu_R \in [0,1], \mu_G \in [0,1]} W(\mu_R, \mu_G).$$

Results 3: Social welfare, first best

Our finding: *first-best social optimum involves complete or partial segregation.*

If for all $x \in [0, (p + \kappa + \lambda)/2]$:

$$s''(x) > -\frac{4}{\lambda}\, s'(x) \tag{17}$$

then any social optima involves complete or partial segregation.

Intuition: a first-best social planner is able to *control* the wage gap. By increasing segregation it creates more homogenous networks. Therefore employment is higher. Since the wage gap remains the same, increasing segregation creates more social welfare.

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We specify functional forms for $s(x)$, $F(L_A, L_B)$, and $U(x)$.

- $$s(x) = \frac{c_0 + c_1 x}{1 + c_0 + c_1 x}.$$

  where c_0 is the rate at which workers directly obtain info on jobs, while c_1 measures the strength of having friends. $s_0 = s(0)$ is the employment probability when only direct search is used; it follows that $s_0 = c_0/(1 + c_0)$.

- Knowing that about half of jobs are obtained through friends, we can impose the following restriction (focusing on the case of complete segregation in which $\mu_R = 1$ and $\mu_G = 0$):

  $$c_0 = c_1(p + \kappa + \lambda)/2.$$

- We choose a modest inbreeding homophily magnitude, i.e. $\lambda = 3(p + \kappa)$ (e.g. Mayer and Puller (2008) come with much bigger numbers, such as black students are 17 more likely to be friends than 2 random students, Asians 5 times more likely etc)
- We next impose that the employment rate is 95 percent in case of complete segregation, and thus solve:

$$\frac{2c_0}{1 + 2c_0} = 0.95,$$

which implies that we can compute $s_0 = 0.90$, and further that $c_1(p + \kappa) = 4.75$ and $c_1\lambda = 14.25$.

- $$F(L_A, L_B) = \theta L_A^{\alpha} L_B^{1-\alpha}.$$

- $$U(x) = 1 - e^{-\rho x}.$$

- The coefficient of absolute risk aversion: 6.6×10^{-5} to 3.1×10^{-4} (Gertner 1993, Metrick 1995, Cohen and Einav 2007). We choose 1.0×10^{-4}, which means a coef of relative risk aversion of 4 at a wealth level of $ 40,000.

- Productivity parameter, θ chosen such that average income equal $ 40,000 in the case of complete segregation, $(\mu_R, \mu_G) = (1, 0)$, and $\alpha = .5$. Since in that situation $w_A(1, 0) = w_B(1, 0) = \theta/2$, we have $\theta = 80,000$.

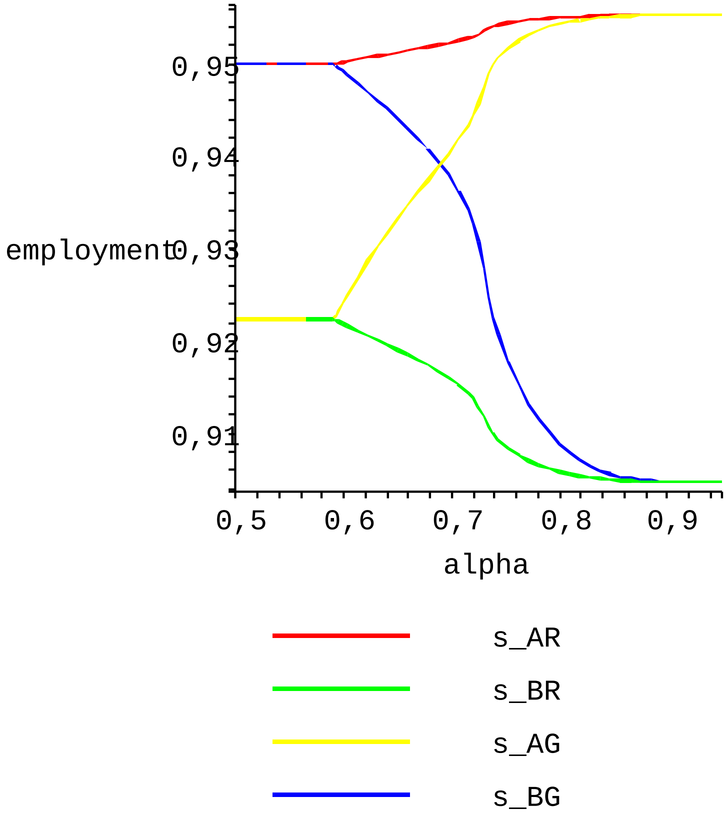
Simulation

For our calibration we set the following parameters:

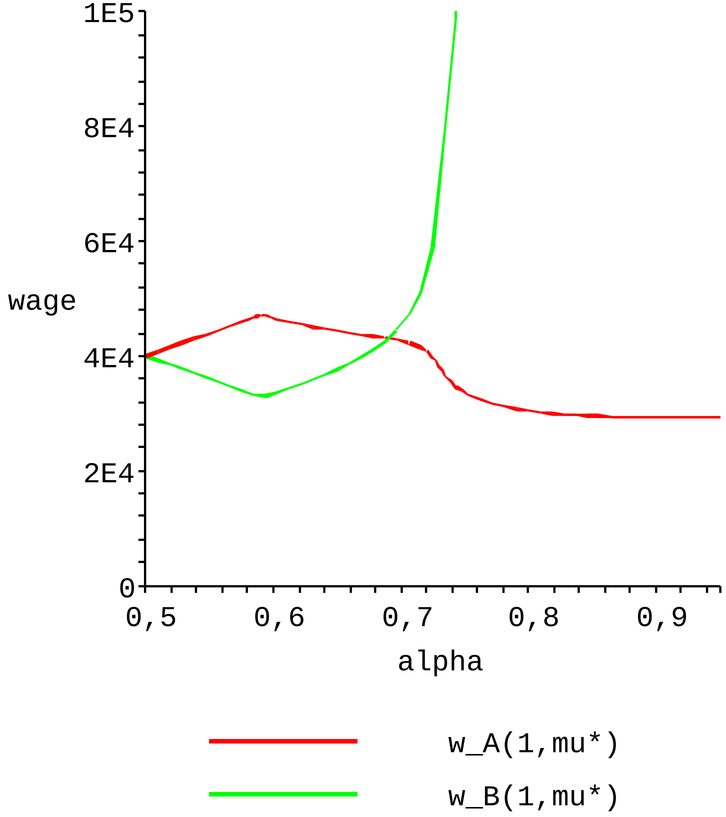
Parameter	Value
s_0	.9048
$c_1(p+\kappa)$	4.75
$c_1\lambda$	14.25
ρ	1.0×10^{-4}
θ	80,000

We do comparative statics on α, the productivity parameter in the production function $F(L_A, L_B)$. Note that α measures the attractiveness of job A wrt job B. If $\alpha > 1/2$, then job A is more attractive than job B.

The employment gap



The wage gap



Simulation summary

- The empirically most relevant situation is when α is between .59 and .68. In those cases, wages of R-workers are higher and so is their employment rate.
- When $\alpha = .59$, then the wage gap is about 30 %. By choosing B, G-workers trade off a 30 percent wage gap against a 3 percent drop in employment when choosing A. This is due to risk aversion. Agents give much more weight to the small probability of getting unemployed and earning 0. To avoid this, agents accept a much lower wage.

Second-best policy

We compare two policies:

1. A ‘laissez-faire’ policy, resulting in the equilibrium above
2. A policy that enforces complete integration, such that $\mu_R = \mu_G$.

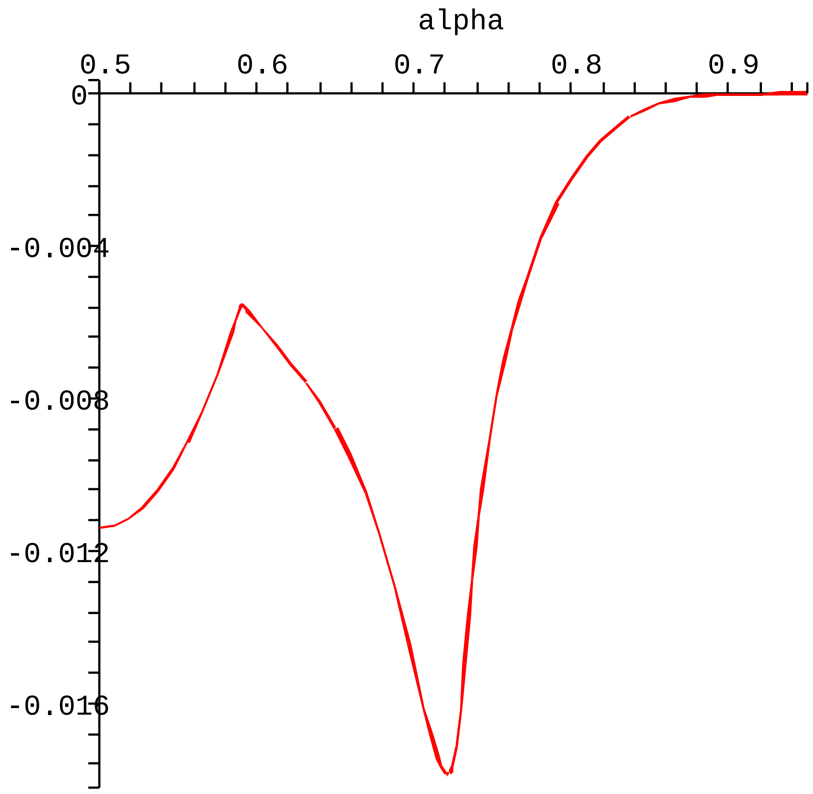
The latter policy eliminates any *inequality* between Reds and Greens. However, integration will also *increase unemployment*. We determine which effect is larger.

- In case the government stabilizes integration, we still impose the equilibrium condition, which is in this case symmetric.

$$\Pi_A^R(\mu^S, \mu^S) = \Pi_B^R(\mu^S, \mu^S) = \Pi_A^G(\mu^S, \mu^S) = \Pi_B^G(\mu^S, \mu^S).$$

- In the symmetric case there is complete equality. On the other hand, in the case of segregation, we consider the equilibrium allocation $(\mu_R, \mu_G) = (1, \mu^*)$, such that Reds obtain a higher payoff than Greens.
- Therefore, we might face a tradeoff when assessing an integration policy. It enforces equality, but it might decrease employment.

Percentage increase in welfare of enforced perfect integration We plot the increase in social welfare from such an integration policy $I = W(\mu^S, \mu^S)/W(1, \mu^*) - 1$, as a function of α



Is integration ever beneficial?

- An integration policy is only beneficial when society has *additional* distributional concerns that are not captured by the concavity of the individual utility function.
- For example, consider the case of a maximin social welfare function: $W_{\min} = \min_i \Pi_i$.
- Then, in the integrated case, $\mu_R = \mu_G = \mu^S$, everyone obtains the same payoff, whereas in the segregated case workers from group G are worse off. Therefore, $W_{\min}(1, \mu^*) = \Pi_B^G(1, \mu^*)$ and $W_{\min}(\mu^S, \mu^S) = \Pi_B^G(\mu^S, \mu^S)$.

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Conclusion

- We presented a simple model that explains occupational segregation, wage inequality and unemployment differences among different social groups.
- Model points out *potential malefic effects of integration policies*. Integration may make the formation of job contacts more difficult and increase overall unemployment. This effect is larger than the benefic effect of smaller inequality.
- Key difference with Benabou (1993): network effects ’horizontal’ instead of ’vertical’. In Benabou, local education externalities flow from "high" agents to "low" agents. Thus low agents are hurt by segregation. In our model both groups benefit from segregation.