Social networks and labor market transitions

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A B S T R A C T

We study the influence of social networks on labor market transitions. We develop the first model where social ties and job status coevolve through time. Our key assumption is that the probability of formation of a new tie is greater between two employed individuals than between an employed and an unemployed individual. We show that this assumption generally generates negative duration dependence of exit rates from unemployment. Our model has a number of novel testable implications. For instance, we show that a higher connectivity among unemployed individuals reduces duration dependence and that exit rates depend positively on the duration of the last job held by the unemployed worker.

1. Introduction

The importance of social ties in finding a job is documented by a long tradition in sociology and labor economics.1 However, very little work has tried to confront that literature with stylized facts about the anatomy of unemployment. An important paper by Calvó-Armengol and Jackson (2004) goes a long way into bridging that gap. They construct a model where it is shown that if social ties are important, then one should observe negative duration dependence of exit rates from unemployment.

The present paper builds on that contribution by proposing another mechanism through which social ties may affect duration dependence, which we believe is more quantitatively significant. The network of social ties in our approach is endogenous instead of fixed as in Calvó-Armengol and Jackson's.2 We assume that a bond between an employed and an unemployed worker, which increases the unemployed's likelihood of finding a job, is less likely to arise than between two employed workers—an assumption we refer to as economic homophily.3 We show that this simple and plausible assumption has a number of implications, one of which is negative duration dependence of exit rates. This is because the long-term unemployed then have fewer connections with employed workers than the short-term unemployed, which reduces their exit rates compared to the latter. We find that the amount of duration dependence introduced by that mechanism is far higher quantitatively than under a fixed network.

The effect we highlight is therefore that workers accumulate social capital (as defined by the stock of ties with employed workers) during employment, that this stock is depleted during unemployment, and that social capital increases the likelihood of finding a job.

We study a dynamic process where job status and social ties coevolve through time. This process allows us to investigate in detail the properties of duration dependence. We notably analyze how changes in the model's parameters affect the magnitude of duration dependence. We do so by analytically solving a mean-field approximation of our model and confirm the analytical results by running numerical simulations.

While some of our results are intuitive, such as the link between homophily and duration dependence, others are more subtle. For example, consider the likelihood of formation of a new tie—thereafter referred to as connectivity—between two unemployed workers. We find that an increase in the connectivity of the unemployed reduces duration dependence. Why? When this connectivity is higher, a long-term unemployed will have relatively more unemployed friends. These friends constitute a form of latent social capital. They are not directly helpful but they become helpful when they find a job. Thus, prospects of finding a job for the long-term unemployed are indirectly improved, which explains the reduction in duration dependence. At the extreme, if
the unemployed connectivity is very high this effect can even overcome the direct effect of homophily and lead to positive duration dependence. We develop similar analysis for the other parameters of the model.

Another important prediction of our model is that exit rates positively depend on the duration of the last job held by the unemployed worker. This is again due to the greater connectivity between two employed workers as compared to between an employed and an unemployed. People who have been employed longer have more ties with employed workers than those who have been employed for a shorter time. Hence, the former will find jobs more easily than the latter if they become unemployed.

Finally, we look at the extent of social segregation that emerges between the employed and unemployed. We define segregation as the difference between the employed and the unemployed in the fraction of employed workers whom they know. This segregation turns out to be quite low when the labor market turnover is sufficiently high. The labor market plays a mixing role, offsetting the original bias in tie formation.

That establishing a tie with an employed is easier when one is also employed, our key assumption, is uncontroversial and well documented. The workplace is an important locus of social interaction, and residential segregation by income and economic status also makes it more likely that the employed match together rather than with the unemployed in out-of-workplace social interactions such as bars, sports clubs, school committees, and so on. The mechanism we study is also consistent with descriptive accounts of social exclusion and on how long spells of unemployment progressively isolate people from the workplace.

To further motivate our analysis, we provide a few relevant statistics computed from the 2001 wave of the International Social Survey Program (Klein and Harkness, 2005). This survey covers 29 countries, and focuses on social networks. Over all the individuals who have ever worked, 41.7% first found out about their job through social networks. This confirms the key role played by networks in job search. Conversely, 33.8% of the people affirm that, in the past year, they have helped someone they know to find a job. This percentage varies with the job status. It is equal to 45.9% for the full-time employed, 28.4% for the unemployed, and 20.7% for the housewives and housemen. These differences are consistent with our assumption that a connection with an employed is more useful to find a job than a connection with an unemployed. Finally, people were also asked about their number of close friends. The average total number of close friends for a full-time employed is 9.29, among which 2.14 are friends at work. The unemployed report having 0.16 friends at work, which is likely due to incorrect answers or measurement errors. Housewives and housemen have 6.64 close friends on average, among which 0.11 reported at work.

These simple statistics of course do not allow discrimination between fixed and endogenous networks. There is a large literature in sociology on the evolution of social networks (see Doreian and Stokman, 1997).

opposite conclusions are reached. A recent study by Abbring et al. (2002) controls for unobserved heterogeneity and finds evidence of true negative duration dependence at long durations. Rosholm (2000), reaches similar conclusions, as do Arulampalam et al. (2000). But Steiner (2001), using German data, does not find duration dependence, while Van den Berg and Van Ours (1996), using US data, find duration dependence for some groups but not all. Our analysis describes a new mechanism generating true duration dependence.10

The remainder of the paper is organized as follows. The model is introduced in Section 2. We show that negative duration dependence emerges in Section 3 and study comparative statics in Section 4. Section 5 looks at duration dependence in previous spells while Section 6 studies social segregation. Section 7 concludes.

2. The model

Our model is a minimal model designed at capturing the idea that social ties are more likely to arise between people of similar labor market status (“economic homophily”). In particular, we abstract from phenomena like price determination in general equilibrium, or the resources needed for establishing and maintaining social ties. We believe that our results will likely be robust to extensions of the model preserving the economic homophily property. The reason is as follows: introducing optimization would allow endogenizing the main parameters that drive our results, namely the rates at which the links between individuals are established and destroyed, and the aggregate rates of job creation and job destruction. Yet while our results rest on these parameters being constant (and in particular, that the link creation probabilities only depend on the individual’s current labor market status rather than his whole labor market history), they do not rest on them being exogenous; one could potentially add a modelling block that determines those parameters, and our analysis of duration dependence and of the evolution of social capital would remain unchanged, as long as our assumption of constant parameters remains a good approximation. If this assumption fails to hold, however, our conclusions may have to be modified.

We consider a group of $n$ individuals with similar characteristics, looking for similar jobs. In the version of the model used for numerical simulations, time is discrete. At each date $t=0, 1, ...,$ an individual $i$ is either employed or unemployed. The state of the labor market is described by a function $S_t$ such that $S_{t+1} = 1$ if $i$ is employed at $t$ and 0 if unemployed. Aggregate unemployment $u_t$ at time $t$ is $u_t = n - \sum_i g_{it}$.

At each date $t$, people are socially related to each other. These social relations are described by the function $g_{ij,t}$ such that $g_{ij,t} = 1$ if $i$ and $j$ are connected and 0 if not. We assume that relations are asymmetric: $g_{ij,t} \neq g_{ji,t}$. The resulting pattern of ties is a social network $g_t$. At $t=0$, the initial labor state $S_0$ and the initial social network $g_0$ are randomly chosen. Labor state and ties then coevolve through time in the following manner.

Job destruction: the transition rate from employed to unemployed is constant and equal to $d$.

Job creation: this process determines who finds a new job. At any date $t$, an expected flow of hired jobs are created. The flow probability that an unemployed becomes employed is proportional to his number of ties with employed workers. Formally, let $x_t(l) = \sum_i g_{it}$.

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4 See e.g. Granovetter (1995, p. 152).

5 This concerns the current job if currently employed, and the previous job if currently unemployed (see question 29 of the survey).

6 See question 28D of the survey. Among the 37,169 individuals interviewed, 15,682 are full-time employed, 2812 are unemployed, and 3565 are housewives and housemen.

7 See questions 15, 16, and 17 of the survey.

8 Unemployed report having 0.16 friends at work, which is likely due to incorrect answers or measurement errors. Housewives and housemen have 6.64 close friends on average, among which 0.11 reported at work.

9 These simple statistics of course do not allow discrimination between fixed and endogenous networks. There is a large literature in sociology on the evolution of social networks (see Doreian and Stokman, 1997).

10 If the mechanism uncovered in this paper were the only one, duration dependence would go away once one controls for social capital in a duration model. However, this does not mean it is just another form of unobserved heterogeneity. For one thing, social capital is not an exogenous individual characteristic but its heterogeneity arises endogenously as a result of differing labor market histories across individuals. Second, the unobserved heterogeneity critique focuses on the fact that regression analysis spuriously delivers duration dependence while there is no duration dependence at the individual level: if one could estimate duration dependence with individual fixed effects it would go away. That is not true in our model: even with individual fixed effects, duration dependence arises, because social capital is not a fixed individual characteristic but does fall endogenously over time during the unemployment spell.
denote the number of ties that individual \(i\) has with employed workers. Then,\(^\text{11}\)

\[
\text{probability}(s_{it} + 1 = 1|s_{it} = 0) = h u_{i}, \quad \frac{x_{i}(i)}{\sum_{j} x_{j}(j)}, \quad (1)
\]

Since \(\sum_{j} x_{j}(j)\) is the average number of ties of an unemployed with an employed worker, this formula delivers an average job finding rate equal to \(h\).

Tie destruction: any given tie is destroyed with probability \(l\).

Tie creation: the probability of formation of a new connection between two individuals depends on their job status:

- a. If \(i\) and \(j\) are employed at \(t\) and \(g_{ij,t} = 0\), there is a probability \(p_{EE}\) that a tie is formed between them and then \(g_{ij,t+1} = 1\).
- b. If \(i\) and \(j\) are unemployed at \(t\) and \(g_{ij,t} = 0\), there is a probability \(p_{UU}\) that a tie is formed between them and then \(g_{ij,t+1} = 1\).
- c. If \(i\) is employed and \(j\) unemployed, or vice versa, the corresponding probability is \(p_{UE}\).

In our analysis, we focus on situations where people have a greater chance to connect with people of their own job status. We assume that \(p_{EE} > p_{UU}\) and \(p_{UU} > p_{UE}\). This captures the presence of economic homophily in the formation of social ties.\(^\text{12}\)

We have defined a Markov process on the set of job status and ties. This process captures in a simple way the property that connections with the employed have a positive impact on the likelihood of finding a job. Eq. (1) could be interpreted as follows. A total number \(h\) of jobs per unemployed worker is created during period \(t\). Those who hear about them first are the employed. They employed tell about the jobs to all their unemployed friends. Then, the unemployed then apply to all the jobs to their unemployed friends. Employers finally hire randomly from all the applicants to a given position. If \(h\) is not too high, one can neglect cases where an unemployed gets more than one offer, and a good approximation to an unemployed’s probability of finding a job is Eq. (1), which tells us that the probability of being hired is proportional to the number of ties one has with employed workers.

We can look at fixed social networks by simply setting \(\lambda = p_{EE} = p_{UU} = p_{UE} = 0\). This allows us to compare, in the next section, the effect of fixed and endogenous networks. Finally, observe that networks affect the distribution of jobs among individuals and across time, but not the aggregate level of unemployment. This is because the average number of jobs created in period \(t\) is \(h u_{i}\), while the average number of jobs destroyed is \(d(n - u_{i})\). In the long-run, the level of unemployment should thus be equal to \(nd/\lambda\).\(^\text{13}\)

In the remainder of the paper, we investigate the properties of the model through a combination of mean-field analysis and numerical simulations. We study how the economic and social parameters affect the dynamics of jobs and ties, and provide economic interpretations of the results. To do so, we find useful to formally define the social capital and the latent social capital of an individual as follows.

**Definition 1.** The social capital of individual \(i\) at time \(t\) is the number of ties that \(i\) has with employed workers. His latent social capital is the number of ties he has with unemployed workers.

Formally, \(i\)’s social capital is \(x_{i}(i) = \sum_{j = 1}^{n} s_{ij} g_{ij} \) while his latent social capital is \(y_{i}(i) = \sum_{j = 1}^{n} (1 - s_{ij}) g_{ij}\). The sum of both variables yields \(i\)’s total number of ties \(\sum_{j = 1}^{n} g_{ij}\).

**3. Negative duration dependence**

In this section we first solve for a mean-field approximation of the model. We determine a sufficient condition under which negative duration dependence emerges. This condition is generally, but not necessarily, satisfied. We also show that in specific circumstances, positive duration dependence may emerge despite economic homophily. We then complement this analysis by numerical simulations.

We now assume that there is a continuum of workers with total mass 1. The evolution equation for the number of links with the employed of an unemployed worker can be written as follows:

\[
\dot{x}_{i}(i) = -\lambda x_{i}(i) + p_{EE} (1 - u_{i}) - d x_{i}(i) + y_{i}(i) h.
\]

The first term is the natural attrition of social ties. The second term is the inflow of new links generated by bonding with the employed. The third term is the outflow due to the job losses of the individual’s employed friends. Finally, the last term is the inflow due to the job finding of the individual’s unemployed friends.

This is an approximation in two respects. First, the second term assumes that the total employed population eligible for forming new ties with the individual is \(1 - u_{i}\), i.e. all employed workers. Thus we assume that the network is sparse: individual networks are much smaller than the whole population. It means that we can neglect those employed workers who already have ties with the individual.\(^\text{14}\)

Second, the last term ascribes a uniform job finding rate \(h\) to the individual’s unemployed friends, equal to the average in the population. As in any mean-field approximation, we replace a local variable by its global mean. This involves both (i) applying the law of large numbers to the set of people connected with the individual, which is granted since there is continuum of workers in our mean-field approximation,\(^\text{15}\) and (ii) neglecting any local variation in the job finding probability of a person’s network, that is, in the quality of his or her friends’ network. While we know that the real dynamics is more complicated, outcomes from the mean-field approximation usually predict well outcomes in the real dynamics and the fit between both can be checked by simulations. In our case, this is confirmed by the fact that the degree of social segregation is low in our numerical simulations, as shown in Section 4.

We get a similar formula for the evolution of \(y_{i}(i)\):

\[
\dot{y}_{i}(i) = -\lambda y_{i}(i) + p_{EE} u_{i} - h y_{i}(i) + dx_{i}(i).
\]

The unemployed worker’s job finding rate is then given by

\[
h_{i}(i) = \frac{x_{i}(i)}{\bar{x}_{i}},
\]

where \(\bar{x}_{i}\) is the mean of \(x\) in the unemployed population.

The evolution of the number of ties of each kind for an employed worker follows the same laws, with \(p_{EE}\) replaced with \(p_{EE}\) and \(p_{UU}\) replaced with \(p_{EE}\):

\[
\dot{x}_{i}(i) = -\lambda x_{i}(i) + p_{EE} (1 - u_{i}) - d x_{i}(i) + y_{i}(i) h,
\]

\[
\dot{y}_{i}(i) = -\lambda y_{i}(i) + p_{EE} u_{i} - h y_{i}(i) + dx_{i}(i).
\]

We now solve these equations for the case where the economy is in steady state, i.e. \(u_{i}\) and \(\bar{x}_{i}\) are constants. In particular, \(u_{i} = \frac{n}{d + h} = u\).\(^\text{15}\)

\(^{11}\) If no unemployed has any tie with an employed and the denominator is equal to zero, simply set \(\text{probability}(s_{it} = 1|s_{it} = 0) = h\). If the right hand side is greater than one, we set the probability equal to one. Both events are very unlikely and almost never occurred in the simulations.

\(^{12}\) As a check, we also ran simulations under the alternative assumptions of no homophily \((p_{EE} = p_{EE} = p_{UU})\) and economic “heterophily” \((p_{EE} = p_{EE} = p_{UU})\). Consistent with our explanations, we find that duration dependence disappears under no homophily and becomes positive under heterophily.

\(^{13}\) This was confirmed by the simulations, up to negligible fluctuations induced by deviations from the law of large numbers.

\(^{14}\) This assumption is realistic in most contexts. It considerably simplifies the formulas but is not needed for solving the model. Under a non sparse network the relevant term would be \(p_{EE} = (1 - u_{i})\) and the equations would keep their linear structure. Here we assume that the \(p_{i}\)’s are relatively small and therefore \(x\) and \(y\) are small implying that the term \(p_{EE}\) is second order and can therefore be neglected.

\(^{15}\) Our first assumption implies that the measure of this continuum is equal to zero. This mathematical property allows both assumptions to hold simultaneously: an individual is negligible compared to his set of neighbors and this set of neighbor is negligible compared to the whole population.
The block (Eq. (2))-(Eq. (3)) can be written in matrix form:

$$
\frac{d}{dt} \begin{pmatrix} x_t(i) \\ y_t(i) \end{pmatrix} = \begin{pmatrix} -(\lambda + d) & h \\ d & -(\lambda + h) \end{pmatrix} \begin{pmatrix} x_t(i) \\ y_t(i) \end{pmatrix} + \begin{pmatrix} p_{EE}(1-u) \\ p_{UE}u \end{pmatrix}.
$$

(6)

It can be checked straightforwardly that the eigenvalues of this system are \(-(\lambda + h + d)\) and \(-\lambda\) with respective eigenvectors given by \(1 \quad -1\) and \(h \quad d\). Also, the steady state solution, which gives the number of ties of each kind for a worker who has been unemployed forever, is

$$
\begin{pmatrix} x_\infty \\\n y_\infty \end{pmatrix} = \begin{pmatrix} \frac{hp_{EE}u + (\lambda + h)p_{UE}(1-u)}{\lambda(h + d)} \\ \frac{(\lambda + d)p_{EE}u + dp_{UE}(1-u)}{\lambda(h + d)} \end{pmatrix}.
$$

(7)

Consequently, the generic solution to (Eq. (6)) is

$$
\begin{pmatrix} x_t(i) \\ y_t(i) \end{pmatrix} = A_1(i)e^{-(\lambda + h + d)(t-t_0)} \begin{pmatrix} 1 \\ -1 \end{pmatrix} + A_2(i)e^{\lambda(t-t_0)} \begin{pmatrix} h \\ d \end{pmatrix} + \begin{pmatrix} x_\infty \\ y_\infty \end{pmatrix},
$$

where \(t_0\) is the date of the start of the unemployment spell and \(A_1(i)\) and \(A_2(i)\) are the integration constants. These are in turn pinned down by the initial conditions

$$
x_{t_0}(i) = A_2(i)h + A_1(i) + x_\infty; \quad y_{t_0}(i) = A_2(id - A_1(i) + y_\infty.
$$

This yields the following formulas:

$$
A_1(i) = \frac{d(x_{t_0}(i) - x_\infty) - h(y_{t_0}(i) - y_\infty)}{h + d} \quad A_2(i) = \frac{(x_{t_0}(i) - x_\infty) + (y_{t_0}(i) - y_\infty)}{h + d}.
$$

Each of the roots captures a different adjustment process. Root \(-\lambda\) captures the adjustment in the overall number of ties of the individual. Root \(-(\lambda + h + d)\) captures the adjustment in the relative proportion of ties.

The dynamics for the employed are similar, except that \(p_{UE}\) is replaced with \(p_{EE}\) and \(p_{UU}\) is replaced with \(p_{UE}\). The transitional dynamics are unchanged but the long-run target is now given by

$$
\begin{pmatrix} x_\infty \\ y_\infty \end{pmatrix} = \begin{pmatrix} \frac{hp_{EE}u + (\lambda + h)p_{EE}(1-u)}{\lambda(h + d)} \\ \frac{(\lambda + d)p_{EE}u + dp_{EE}(1-u)}{\lambda(h + d)} \end{pmatrix}.
$$

(8)

Now that we have solved for the evolution of the number of links depending on initial conditions at the start of the unemployment spell, we are ready to establish a result concerning duration dependence:

**Proposition 1.** Assume economic homophily and

$$(1-u)(p_{EE}-p_{UE}) > u(p_{UU}-p_{UE}).$$

Then there is monotonic negative duration dependence of exit rates for all unemployed workers.

**Proof.** Observe that for the unemployed, \(x_t(i) + y_t(i)\) has only root \(-\lambda\) in its adjustment dynamics. Thus it is monotonic over time and always between \(x_t(i) + y_t(i)\) and \(x_\infty + y_\infty\). Similarly, for the employed, calling \(t_e\) the start of the employment spell, \(x_t(i) + y_t(i)\) is always between \(x_t(i) + y_t(i)\) and \(x_\infty + y_\infty\). Putting these two things together, we see that in steady state, i.e. when the distribution of the number of links for an individual is stationary, \(x_t(i) + y_t(i)\) is always between \(x_\infty + y_\infty\) and \(x_\infty + y_\infty\). Therefore, going back to the case of an unemployed worker, \(A_1(i) > 0\) if and only if \(x_\infty - x_\infty + y_\infty - y_\infty > 0\). Using Eq. (7) and Eq. (8), we see that this is equivalent to

$$
(1-u)(p_{EE}-p_{UE}) > U(p_{UU}-p_{UE}).
$$

(9)

Turning now to the other root, we use the same reasoning, noting that \(dx_t(i) - hy_t(i)\) has monotonic adjustment dynamics in each state, so that it is always between \(dx_\infty - hy_\infty\) and \(dx_\infty - hy_\infty\). Therefore, \(A_1(i) > 0\) if and only if \(dx_\infty - hy_\infty - dx_\infty + dy_\infty > 0\). Using again Eq. (7) and Eq. (8), is equivalent to

$$
d(1-u)(p_{EE}-p_{UE}) - u(p_{UU}-p_{UU}) > 0.
$$

This always holds, therefore if Eq. (9) holds then \(A_2(i) > 0\) and \(A_1(i) > 0\) for all unemployed workers. This in turn implies that \(x_t(i)\) and therefore \(h_t(i)\) are monotonically decreasing with time. This completes the proof. QED.

Note that condition (9) is highly plausible for reasonable parameter values, as we expect \(u\) to be small compared with \(1 - u\), while \(p_{UU} - p_{EE}\) and \(p_{UU} - p_{EE}\) are likely to have similar values. But it does not necessarily hold. If it is violated, then typically \(p_{UU}\) will be large relative to \(p_{EE}\) and/or \(u\) will be large. In such a case, when the unemployed bond less often with the employed directly, their large rate of connections with other unemployed workers implies that they build latent social capital over time at a fast rate, which may defeat duration dependence as this latent social capital is transformed into actual social capital due to the fact that the unemployed connections find jobs.

We next run numerical simulations to illustrate the emergence of negative duration dependence. Simulations are conducted for \(n = 100\) individuals and \(T = 20,000\) periods.\(^{16}\) Our baseline parameter values are set as follows. On the evolution of jobs, \(h = 0.12\) and \(d = 0.02\). These numbers, which imply an unemployment rate of 14%, are not meant to calibrate any real world economy, but are in the ballpark of the European experience for a period equal to one trimester. For example, the monthly job loss rate in France, according to Cohen et al. (1997), is 0.005 for men and 0.008 for women, and the monthly job finding rate is 0.059 for men and 0.047 for women. On the evolution of ties, we set \(\lambda = 0.01, p_{UU} - p_{EE} = 0.02\) and \(p_{UE} = 10^{-5}\). For these values economic homophily is very strong, and the speed of tie turnover is somewhat decreasing, which con

\(^{15}\) In addition, these values satisfy the condition of Proposition 1, an assumption that we maintain in what follows.\(^{16}\) We depict in Fig. 1 the average sample probability of finding a job as a function of the time spent unemployed. Dashed lines represent the 95% confidence interval. For a given duration \(t\), the average is taken over all observations \(i\)'s) such that \(i\) is unemployed at \(t\) and the length of this current unemployment spell is equal to \(t\). The function is clearly decreasing, which confirms the emergence of negative duration dependence at baseline parameter values.

\(^{16}\) We only use data from periods 10,000 to 20,000 to remove any effect due to the initial network and labor status.

\(^{17}\) We could not find any quantitative data on probabilities of link formation and link deletion.

\(^{18}\) We also looked at situations where the condition is not satisfied. For instance, if \(h = d = 0.06\) (\(u = 50\%\)), \(p_{UU} = 0.011, p_{EE} = 0.01\) but \(p_{UE} = 0.1\), simulations confirm the emergence of positive duration dependence.
4. Comparative statics

We next study how the parameters of the model affect the magnitude of duration dependence. We derive analytical results based on our mean-field analysis and then check the validity of these results through simulations. We find that the parameters driving the evolution of the network have a strong impact on labor market transitions and that duration dependence is quantitatively much stronger when the network is endogenous than when it is fixed.

What does the model predict for the determinants of duration dependence? There are several ways to measure such duration dependence. Most of those measures (such as the sample correlation between exit rates and spell duration) cannot be tractably computed because such computation would involve the stationary distribution of spells for which no simple expression can be found due to the non constancy of exit rates. However, one measure that is easy to compute is the wedge between the exit rate from unemployment of an unemployed worker who has just become unemployed and enjoyed an infinite preceding spell of employment, and the exit rate of an unemployed worker with an infinite duration. Computed as a ratio, this measure is equal to $\delta = \frac{p_{UE}}{p_{UE} + (\lambda + h)p_{EE}(1-u)}$, i.e., given our preceding formulas:

$$\delta = \frac{h p_{UE} u + (\lambda + h)p_{EE}(1-u)}{h p_{UE} u + (\lambda + h)p_{EE}(1-u)}$$

Given this formula, straightforward computations allow to prove the following:

**Proposition 2.** The following claims are satisfied:

(i) $\delta > 1$ if and only if

$$\frac{\lambda + h}{h}(1-u)(p_{EE} - p_{UE}) > u(p_{UU} - p_{UE}).$$

(ii) $\frac{\partial \delta}{\partial p_{UE}} > 0$.

(iii) $\frac{\partial \delta}{\partial p_{UU}} < 0$.

(iv) $\frac{\partial \delta}{\partial p_{UE}} < 0$ if and only if $(\lambda + h)(1-u)\sqrt{p_{UU}} > hu\sqrt{p_{EE}}$.

(v) $\frac{\partial \delta}{\partial \lambda} > 0$

Thus we see that duration dependence as measured by $\delta$ arises (i.e. $\delta > 1$) provided Eq. (10), which is weaker than Eq. (9), holds. It is stronger when the rate of intra-employed bonding $p_{EE}$ or tie attrition $\lambda$ goes up, but is reduced by both $p_{UU}$ and (typically) $p_{UE}$.

We next check whether this result indeed predicts well the effect of the parameters on actual duration dependence. Table 1 reports simulation outcomes. Each row corresponds to a different set of parameter values, starting with the baseline. The first four columns report the average probability of getting out of unemployment when the duration of the unemployment spell is equal to 1, 5, 10 and 50. Standard errors are reported in parenthesis below. The last column gives the ratio of the average probabilities to find a job for short-term ($t = 1$) versus long-term ($t = 50$) unemployed. Observe that this measure is not exactly equal to $\delta$ so in principle simulation results could differ from those of Proposition 2. We discuss the effect of each parameter in turn. We focus here on the determinants of network evolution.

4.1. Effect of $p_{UE}$

The most straightforward determinant of duration dependence is $p_{UE}$, the connectivity between the employed and the unemployed. Comparing the second row of Table 1 with the baseline confirms Proposition 2. An increase in $p_{UE}$ unambiguously reduces duration dependence. The mechanism is simple: the gross inflow of ties between an unemployed individual and employed workers is greater when $p_{UE}$ goes up, so that the stock of such ties goes down more slowly during the unemployment spell. Therefore, the difference between the social capital of a long-term unemployed and a short-term unemployed is smaller, and so is the difference between their exit rates. This is confirmed by looking directly at the average number of connections with employed workers. It turns out that the increase in $p_{UE}$ has a small positive effect on the social capital of the short-term unemployed but a large impact for long-term unemployed. Interestingly, $p_{UE}$ also affects the ties of a short-term unemployed although this effect is weak. This is an indirect effect going mainly through the

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19 Parameter values which are not reported in the table are set at baseline.

20 We also looked at the effect of $h$ and $d$. Both parameters affect the unemployment rate, which complicates the study of duration dependence. We find that an increase in $h$ increases duration dependence while an increase in $d$ has little impact.
long-term unemployed's stock of ties. Consequently, an unemployed worker and other unemployed workers gradually latent social capital more for the long-term unemployed than for the connections to them become valuable to
During any time interval, a fraction of the unemployed implies that improvements in one lead to improvements in the other. between latent and non-latent social capital. Labor market turnover their previous unemployment spell. Second, there is a relationship unemployed is much weaker, going through a small echo effect from
Thanks to the interaction connected with unemployed workers therefore indirectly increases the social capital of the short-term unemployed more than for the long-term unemployed, and the same is true for exit rates.

4.2. Effect of \( p_{EE} \)
Next, we look at the effect of \( p_{EE} \) connectivity between the employed. Contrasting the second and third rows of Table 1 shows that duration dependence is larger, the larger \( p_{EE} \), which is consistent with Proposition 2. This is because \( p_{EE} \) has a strong direct effect on a short-term unemployed's number of ties with the employed, while the effect on the long-term unemployed's ties is weaker and more indirect. The most recent ties of a short-term unemployed have been made during his last job, and chiefly depend on \( p_{EE} \). In contrast, \( p_{EE} \) affects a long-term unemployed's stock of ties only through the echo effect of the ties he made during his last job. Again, attrition of that stock during the unemployment spell reduces the effect of \( p_{EE} \) on the long-term unemployed's stock of ties. Consequently, \( p_{EE} \) increases the social capital of the short-term unemployed more than for the long-term unemployed, and the same is true for exit rates.

4.3. Effect of \( p_{UU} \)
How does, now, \( p_{UU} \) affect duration dependence? Clearly, Table 1 and Proposition 2 show that an increase in the connectivity between the unemployed reduces duration dependence. To explain this effect, we rely on the concept of latent social capital introduced earlier. Two properties come into play here. First, an increase in \( p_{UU} \) increases the latent social capital more for the long-term unemployed than for the short-term unemployed. The reason is clear. The stock of ties between an unemployed worker and other unemployed workers gradually builds up during the unemployment spell and \( p_{UU} \) is a key determinant of the latent social capital of long-term unemployed. In contrast, the effect of \( p_{UU} \) on the latent social capital of short-term unemployed is much weaker, going through a small echo effect from their previous unemployment spell. Second, there is a relationship between latent and non-latent social capital. Labor market turnover implies that improvements in one lead to improvements in the other. During any time interval, a fraction of the unemployed find jobs hence connections to them become valuable to find jobs. This means that a fraction of the latent social capital ceases to be latent.\(^{21}\) Being better connected with unemployed workers therefore indirectly increases the connections with employed workers. Thanks to the interaction between the evolution of ties and the evolution of jobs, the long-term unemployed's connections with the employed increases by more than for the short-term unemployed, and so do their exit rates.

4.4. Effect of \( \lambda \)
For the rate of tie attrition, simulations confirm, again, Proposition 2. A higher \( \lambda \) increases duration dependence. When \( \lambda \) is higher, the stock of ties that any individual has inherited from his past experience erodes faster during the adjustment path associated with his current labor market status. (Mathematically, this shows up in both eigenvalues becoming more negative). This effect widens the gap between the social capital of the employed and that of the unemployed. Therefore, measured duration dependence goes up.

5. Duration dependence in previous spells
Our model contributes to explain the well-documented phenomenon of negative dependence of exit rates on the duration of unemployment spells. In this section, we show that it has other, more novel implications, which is that exit rates should also depend on the duration of previous employment and unemployment spells.
First, exit rates should depend positively on the duration of the last job. Because of economic homophily, we expect individuals who have been employed for a longer time to have relatively more ties with employed workers. By working longer, they accumulate a better social capital. We therefore expect their exit rates from unemployment to be larger. This is confirmed by simulation results at baseline parameter values. Table 2 reports the exit rates of two groups of unemployed: individuals whose previous job lasted less than or equal to 10 periods and those whose previous job lasted between 31 and 40 periods. Exit rates from unemployment are higher for longer durations of previous employment spells. In addition, this difference is larger for the short-term unemployed. Initial differences in social capital generated by the duration of the previous job become less and less important as the

\(^{21}\) Reciprocally, a fraction of the employed loses jobs and connections with them cease to be directly helpful. Thus, a fraction of social capital also becomes latent in any time period.

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Table 1
Effect of changes in parameters.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>50</th>
<th>Ratio 1/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_{UU} = p_{EE} = 0.02 )</td>
<td>0.1297</td>
<td>0.1240</td>
<td>0.1179</td>
<td>0.0825</td>
<td>1.5726</td>
</tr>
<tr>
<td>( \lambda = 0.01 ) ( p_{uu} = 10^{-5} )</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0002)</td>
<td>(0.0014)</td>
<td></td>
</tr>
<tr>
<td>( p_{UU} = 0.01 )</td>
<td>0.1237</td>
<td>0.1212</td>
<td>0.1190</td>
<td>0.1069</td>
<td>1.1574</td>
</tr>
<tr>
<td>( p_{EE} = 0.01 )</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0017)</td>
<td></td>
</tr>
<tr>
<td>( p_{UU} = 0.08 )</td>
<td>0.1271</td>
<td>0.1229</td>
<td>0.1182</td>
<td>0.0948</td>
<td>1.3417</td>
</tr>
<tr>
<td>( p_{EE} = 0.08 )</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0010)</td>
<td></td>
</tr>
<tr>
<td>( \lambda = 0.02 )</td>
<td>0.1413</td>
<td>0.1294</td>
<td>0.1165</td>
<td>0.0620</td>
<td>2.2796</td>
</tr>
<tr>
<td>Fixed net</td>
<td>(0.0002)</td>
<td>(0.0002)</td>
<td>(0.0003)</td>
<td>(0.0013)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.1212</td>
<td>0.1204</td>
<td>0.1197</td>
<td>0.1132</td>
<td>1.0710</td>
</tr>
</tbody>
</table>

---

\(^{22}\) This result is robust to changes in the fixed network. We looked at random networks with various levels of density as well as networks with specific shapes such as the circle, the line, and the star. In all cases, the extent of duration dependence is much lower than for endogenous networks.
unemployment spell lengths. As a consequence, duration dependence tends to be steeper for individuals who have been employed a longer time. In summary,

- **Result 1.** Exit rates from unemployment are positively affected by the duration of the previous period of unemployment. We then look at how the effect of duration dependence tends to be steeper for individuals who have been employed a longer time. In summary,

- **Result 2.** Exit rates from unemployment are negatively affected by the duration of the previous period of unemployment.

6. Social organization

In the previous sections, we studied how social ties affect the labor market dynamics. Our model can also be used in a complementary way to understand the emerging structure of labor relations. Especially, given that new bonds form preferentially among people with the same labor status, we expect some form of social segregation, which are higher when the tie turnover is higher or when the proportion of employed workers among an unemployed's connection. The reverse effects hold for the unemployed's ties with employed people. By contrast, an increase in $p_{UE}$ by the same factor will have a larger impact on the unemployed's ties with other unemployed workers. Consequently, greater social turnover increases the proportion of unemployed people among an unemployed's connection. The reverse effects hold for the employed: because $p_{UE}$ is small, the first mechanism is a small component of that process, so that an increase in $p_{UE}$ by a given factor will only have a small impact on the unemployed's ties with employed people. People among an unemployed's connection. The proportion of unemployed workers is lower.

That greater turnover of social ties increases social segregation between the employed and the unemployed may come as a surprise. It is another aspect of tie dynamics being driven by both social and labor market transitions. Recall, there are two sources of tie formation with employed workers for unemployed ones: establishing a new bond with an employed person ($p_{UE}$) and having an unemployed friend finding a job ($h$). Because $p_{UE}$ is small, the first mechanism is a small component of that process, so that an increase in $p_{UE}$ by a given factor will only have a small impact on the unemployed's ties with employed people. People among an unemployed's connection. The proportion of unemployed workers is lower.

### Table 2
Duration of previous employment spell.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>50</th>
<th>Ratio 1/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1 \leq t \leq 10$</td>
<td>0.1250</td>
<td>0.1196</td>
<td>0.1139</td>
<td>0.0789</td>
<td>1.5840</td>
</tr>
<tr>
<td>(0.0001)</td>
<td>(0.0002)</td>
<td>(0.0002)</td>
<td>(0.0012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$31 \leq t \leq 40$</td>
<td>0.1319</td>
<td>0.1262</td>
<td>0.1200</td>
<td>0.0804</td>
<td>1.6401</td>
</tr>
<tr>
<td>(0.0002)</td>
<td>(0.0002)</td>
<td>(0.0003)</td>
<td>(0.0021)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4
Extent of social segregation.

<table>
<thead>
<tr>
<th>% of unemployed neighbors</th>
<th>Tie turnover * 1</th>
<th>Tie turnover * 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among unemployed</td>
<td>$d = 0.01$, $h = 0.06$</td>
<td>$d = 0.05$, $h = 0.30$</td>
</tr>
<tr>
<td>Among employed</td>
<td>$d = 0.0006$</td>
<td>$d = 0.0004$</td>
</tr>
<tr>
<td>Among employed</td>
<td>$d = 0.0005$</td>
<td>$d = 0.0004$</td>
</tr>
</tbody>
</table>

**7. Discussion and conclusion**

In this paper, we studied a simple model where labor status and social ties coevolve through time. On the one hand, social ties are helpful to find a job. Connections with employed workers increase the unemployed's likelihood of finding a job. On the other hand, labor status affects the evolution of ties. The probability of formation of a new

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23 Also, note that if the dynamics of ties were totally independent of labor market transitions, an equiproportionate increase in $p_{UE}$, $p_{EE}$, $\lambda$, and $p_{UE}$ would have no impact of our measure of social separation.
tie is greater among two individuals who have the same job status. We showed that this simple assumption usually generates negative duration dependence of exit rates from unemployment. The long-term unemployed have less connections with the employed, hence a lower probability to find a job, than the short-term unemployed. We provided a number of stylized results regarding the properties of duration dependence. An increase in the connectivity between employed workers or in the rate of tie attrition increases duration dependence. An increase in the connectivity between workers of different status or in the connectivity between unemployed workers reduces duration dependence.

Our model potentially has a number of testable empirical predictions that future research could test. A first range of predictions is about the tie between labor market history and exit probabilities: these include the widely documented phenomenon of duration dependence, but also the positive influence of the total duration of the previous job on exit rates. However, these predictions are shared with any model where workers accumulate human capital during employment periods and gradually lose it during unemployment spells. A second range of predictions, more specific to our model, is about the coevolution of labor market status and social ties; to test them empirically, one possibility would be to compare communities with different intensities of social interactions (these differences could for example be driven by cultural customs, if one considers different ethnic groups, or by differences in urban structures, if one considers different cities), and correlate these differences with the labor market outcomes of these communities. Another approach would be to use individual data on both employment status and social ties, and examine the correlation between unemployment duration, job duration, and so on, and the number of ties with employed and unemployed workers.

The model could also be enriched by introducing additional margins of economic behavior. This could include wage bargaining, price formation, a time constraint to be allocated between work, search, and socialization, and competing search methods. As stated above, we are reasonably confident that our results would be robust as long as the model exhibits economic homophily. However, these extensions could potentially yield many interesting insights.

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References


