Oskari Vähämaa

Layoff Orders and Occupational Mobility via Unemployment

Aboa Centre for Economics

Discussion paper No. 101

Turku 2015

The Aboa Centre for Economics is a joint initiative of the economics departments of the University of Turku and Åbo Akademi University.

ISSN 1796-3133

Printed in Uniprint
Turku 2015

Oskari Vähämaa

Layoff Orders and Occupational Mobility via Unemployment

Aboa Centre for Economics
Discussion paper No. 101
September 2015

ABSTRACT

This paper examines how a change in layoff order can affect the decomposition and the size of unemployment in an equilibrium model where workers make optimal occupational reallocation decisions. In a calibrated model, a policy that concentrates involuntary unemployment incidences to inexperienced workers decreases workers' incentives to reallocate, compared to an equilibrium where everyone faces an identical unemployment risk, leading also to a decrease in aggregate unemployment. Moreover, given that the human capital depreciation during unemployment spells is strong, this policy change increases the market output and on average does not harm inexperienced workers.

JEL Classification: E24, J62, J68

Keywords: Layoff order, Occupational Mobility, Unemployment

Contact information

Oskari Vähämaa
Department of Economics
University of Turku
FI-20014, Finland
Email: oskari.vahamaa (at) gmail.com

Acknowledgements

I would like to thank Mitri Kitti, Stefan Pitschner, Thijs van Rens, Jouko Vilmunen and Matti Viren for helpful comments and discussions.

1 Introduction

"*We should have a recession. People who spend their lives pounding nails in Nevada need something else to do*" (John Cochrane, Nov 2008)

The importance of swift labor force reallocation to aggregate economic outcomes is widely accepted[1]. At the same time, the reallocation process of declining occupations and industries is thought to be costly[2]. Involuntary unemployment incidences give people a chance to reallocate with smaller costs since foregone wages are an important part of reallocation costs and so unemployment incidences may also have a useful aspect from the whole economy's perspective. However, not all nail pounders in Nevada are willing to move, even if unemployed. In the aftermath of the financial crisis and the collapse of the construction sector, it has been discussed what policy measures could speed up the reallocation process. In this paper, I look at how a layoff order that protects experienced workers over inexperienced ones, affects the reallocation process in a stationary environment. The mechanism is simple: when labor markets are local in the sense of Lucas and Prescott (1974), demand shocks generate involuntary unemployment that does not require reallocation and workers differ in location-specific human capital they possess, the value of waiting is higher for unemployed experienced workers than it is for inexperienced unemployed workers. This implies that different layoff orders are likely to generate a different amount of reallocation unemployment.

In order to formalize the idea, I build a DSGE model where employed and unemployed workers make endogenous reallocation decisions. The model contains a continuum of occupations and a continuum of infinitely-lived workers. Workers accumulate occupation-specific human capital while working. In order to consider different layoff rules, I assume that the goods market is also segmented in the sense that shoppers enter into local markets with a license to consume a fixed amount. Moreover, entering into local markets is uncertain. This generates demand shocks that cannot be sorted out by adjusting prices.

[1]For example, firm dynamic models, such as Hopenhayn and Rogerson (1993), emphasize the efficient transition of labor force between firms. In growth theory, for example, Restuccia, Yang and Zhu (2008), highlight the factor reallocation across sectors as one of the explanations for income and growth differences across countries.

[2]The cost of reallocation includes direct monetary costs such as training costs (Heckman et al ,1999, report that direct training costs are 2000 to 3000 measured in US 1997 dollars) and lost wages during the slow reallocation process. Unemployment spells for workers who reallocate are typically longer than spells for workers who are re-employed in their old sector (For the durations of inter- and intra-sectoral unemployment spells, see, e.g., Shin and Shin, 2008)

From the workers' point of view this means that the local labor markets are like labor markets for stevedores in the past. Workers come to the harbor in the morning and, depending on how many ships have arrived or will arrive during the day, some of them will be hired. This structure creates a situation where some workers have to be laid-off (or not be hired for that day) when the demand is low. Unemployed workers can then either decide to wait for a job or to reallocate. Employed workers make the same decisions, but are, in general, less mobile since reallocation would require them to forgo the current period wage.

The importance of occupational human capital is motivated by the work of Kambourov and Manovskii (2009 a). They find large returns on occupational tenure while firm and industry tenure plays a relatively minor role in explaining wages[3]. Consistent with occupation-specific human capital, they also report sizable wage losses for unemployed workers who, after an unemployment spell, reemploy in a new occupation. However, in order to model the reallocation decisions of different types of workers, it is also important to take into account the costs associated with the waiting unemployment. Kambourov and Manovskii (2009 a) also report wage losses for unemployed workers who do not change occupation. To take this into account in a simple human capital framework, I follow Ljungqvist and Sargent (1998), and assume that human capital can erode during unemployment spells.

In order to keep the model tractable, I abstract from firms by assuming that the experience levels are perfect substitutes. This imposes a clear structure on workers' value functions (i.e. experienced workers are always better off than inexperienced workers with similar job market status) which simplifies the computational process. Note also that this assumption, together with the perfect competition in local labor markets, implies that firms do not care whether they fire inexperienced or experienced workers when the demand is low. Given this set up, I look at how the reallocation across occupations changes when the economy moves from a stationary equilibrium, where everyone is facing an identical unemployment risk, to a stationary equilibrium where inexperienced workers are always laid off first. Given the indifference of firms, these are essentially two different policies imposed by society.

When the model with an equal unemployment risk is calibrated to match the reallocation patterns of unemployed workers in the US, it turns out that,

[3]Estimation results by Sullivan (2010) also support the view that occupational human capital is important. He also emphasize the importance of industry specific human capital if within-firm occupational mobility is allowed.

contrasting with a simplified partial equilibrium analysis, the introduction of the seniority rule actually reduces occupational mobility by 16-27%[4] This occurs because the aggregate level of human capital, the amount of experienced workers in the economy, increases as experienced workers are now more protected against human capital depreciation caused by involuntary unemployed spells. This "insurance" also reduces inexperienced workers incentives to reallocate, given that they have a job, since returns on experience increase. The effects of increasing human capital are also large enough to offset the reduction of the average labor productivity caused by the reduced mobility. Due to these effects the market output produced in the economy increases 1.5-1.6%.

The model considered in this paper builds on the island framework of Kambourov and Manovskii (2009 b). In their paper, islands are interpreted as occupations and workers accumulate occupational human capital in a learning-by-doing-fashion. Different levels of occupation-specific human capital imply that workers' reallocation costs are different. However their focus is quite different as they use the model to study the connections of occupational mobility and wage inequality. I also add demand shocks to this island structure in order to consider layoff practices. Because of this, my model contains elements of mismatch unemployment a la Shimer (2007), even though it does not contain vacancies typically present in mismatch papers. Here it is the inability of shoppers and sellers to meet that leads to a situation where some unemployed workers will rather stay close to their previous job than search for a new one.

By combining mismatch and reallocation unemployment the model developed in this paper is also closely related to a relatively new branch of literature that concentrates on the endogenous reallocation decisions of unemployed workers across local labor markets. In these papers the aim is to understand why unemployed workers may prefer staying attached to their current labor markets even though some other locations could offer better labor market conditions. For example, Alvarez and Shimer (2011) decompose unemployment to rest and reallocation unemployment. In their model, rest unemployment is generated since reallocation to better industries is costly time- and resource-wise, implying that some workers find it optimal to stay inactive in their current industry and wait

[4]The introduction of the new lay off order opens up the possibility of multiple equilibria. This happens since now the actions of inexperienced workers are partially strategic complements. Unemployment probability in an occupation is smaller if all inexperienced workers decide to stay in their current occupations. Results reported are related to the percentage changes associated with the equilibria where the occupational mobility is at its lowest and highest levels possible.

for industry conditions to improve. Carrillo-Tudela and Visschers (2014) take into account the effects of different experience levels at the top of employment status when considering occupational reallocation.[5] However, unlike Carrillo-Tudela and Visschers (2014), who model intra-island unemployment with the setup of Mortensen and Pissarides (1994) at the top of rest unemployment, I, similar to Birchenall (2011), use demand shocks as a driving force behind involuntary intra-island unemployment. These papers have been successful in replicating a variety of labor market facts.[6]My contribution to this literature is to look at how policies implemented by the society, i.e., different layoff orders, can affect the composition of unemployment and other aggregate equilibrium variables, such as the output produced and the average labor marker productivity[7].

The remainder of the paper is organized as follows. Section 2 presents the economy with equal unemployment probability and the economy in which experienced workers are protected. Section 3 analyzes a simplified framework analytically while section 4 states the calibration of the model. Results are reported in section 5 while section 6 looks at the sensitivity of the results. Section 7 concludes the paper.

2 Model

In this section I introduce a model that is used to analyze the effects of layoff orders. Section 2.1 describes a model with an equal unemployment risk while section 2.2. presents a model where experienced workers face an unemployment risk only if there are not enough inexperienced workers to absorb the demand shock. For brevity, I will call this layoff rule a “seniority rule”, even though it is the amount of human capital that workers have that affects their unemployment probability and not the length of their tenure.

[5]With this respect the work by Alvarez and Shimer, 2012, is also closely related. Their paper concentrates on the nature of unemployment for experienced workers.

[6]For business cycles properties, see Carrillo-Tudela and Visschers (2014), and for links between unemployment durations and occupations, see Wiczer (2013). For medium run trends, see Birchenall (2011).

[7]The use of an island model in order to explore effects of a labor market policy means my set up is in spirit similar to Alvarez and Veracierto (1999) who, among other things, look at the general equilibrium effects of minimum wages and firing taxies.

2.1 Economy with an equal unemployment probability

ENVIRONMENT. There is a mass one of infinitely-lived workers distributed along a continuum of locations, islands. Workers differ in location-specific productivity, experience and employment status. I interpret islands as different occupations. The log of productivity level in each location, $ln(z(l))$, is assumed to follow an AR(1)-process. Demand shocks generate involuntary unemployment. With probability p, demand in location l is below the full employment level. When this happens, fraction D of production capacity remains unused. Finally, workers can be either experienced or inexperienced. When an inexperienced worker is working, there is a positive probability, α, that she will become an experienced worker. Experience is location-specific in the sense that if a worker decides to reallocate, she will become an inexperienced worker in her new island. An experienced worker can also become an inexperienced worker during unemployment spells. In each period of unemployment that the experienced worker waits for a job in her current occupation, there is a probability γ that she will become an inexperienced worker. Reallocation to a new location is possible but it will take time. If a worker decides to reallocate, she will not be able to work during that period and at the beginning of the next period she will be allocated to a new location randomly.

TIMING. I assume that the productivities are revealed at the beginning of the period. Next, nature chooses the demand levels for each location. At this point workers discover whether they have a job or not. After this, employed workers decide whether they would like to work for a given wage or whether they prefer to reallocate. Unemployed workers can decide to wait in their current location or to reallocate. After the workers have made their decisions, production takes place. At the end of the period, a fraction of the inexperienced workers that had worked will become experienced and a part of the unemployed experienced workers that decided to wait, as well as all workers that decide to reallocate, become inexperienced.

DEMAND SHOCKS. Workers belong to large families that fully insure them against differences in experience and productivity levels and employment status. That is, each member of the family obtains equal consumption shares. Goods produced in different locations are assumed to be perfect substitutes. I assume that goods markets are also imperfect in the sense that household members have to travel through the archipelago to collect their consumption shares. The weather in front of each island can be good or bad. The probability of bad weather is p. This probability is independent of past realizations and weather conditions in other locations. When the weather is bad, only a fraction $1 - D$, of all consumers find their way to the island and are able to collect their consumption shares, i.e., the aggregate demand at location l

$$C(l) = c(l)h(l),$$

where $h(l)$ is a random variable that takes a value of 1 with probability $1 - p$ and value $1 - D$ with probability p. $c(l)$ is a deterministic consumption share that the representative household has allocated to each consumer. It is set in a way that $c(l) * 1 = y_p(l)$, where $y_p(l)$ is the beginning of a period production potential. The demand shock structure is close to the structure presented in Birchenall (2011). However, in his paper demand shocks are a combination of aggregate shocks and idiosyncratic shocks, while here demand shocks are purely idiosyncratic. Furthermore, in his specification $D = 1$, while I assume D to take some intermediate value between zero and one in order to consider the effects of different lay-off schemes.

PRODUCTION. Production in location l is given by linear production technology

$$y(l) = z(l)(k_{ie} * g_{ie,job} + k_e * g_{e,job}),$$

where k_e and k_{ie} are the levels of human capital for experienced and inexperienced workers, respectively. $g_{ie,job}$ gives the measure of inexperienced workers who were offered a job and decided to work in occupation l while $g_{e,job}$ gives the measure of experienced workers that are working. Due to the local labor markets $g_{i,job}$, $i = \{ie, e\}$, cannot be larger than the measure of type i workers present in that location at the beginning of the period, m_i^b. The evolution of productivity shock is given by

$$ln(z'(l)) = (1 - \rho)a + \rho ln(z(l)) + \epsilon_t',$$

$0 < \rho < 1$ and $\epsilon' \sim N(0.\sigma^2)$. Markets in each location are assumed to be locally competitive, implying that wages are given by

$$w_{ie} = z(l)k_{ie}$$

$$w_e = z(l)k_e$$

The assumption of perfect substitutability between experience levels ensures that wages for experienced workers are always higher than wages for inexperienced workers.[8] Moreover, given the competitive labor markets and perfect substitutability between inexperienced and experienced workers, firms are indifferent with respect to who they hire. Here I simply assume that each worker faces an identical probability, D, of not being hired for a period when demand is low. Note that this probability is equal to the amount of consumers getting lost when the weather is bad. During the low demand periods $g_{i,job}$ is further restricted i.e. $g_{i,job} \leq (1-D)m_i^b$ if demand is low.

WORKERS' PROBLEM. Given the insurance arrangement, workers simply maximize their lifetime incomes. I assume that workers earn income b_r when they are waiting and workers who decide to switch occupations (i.e. searchers) do not earn anything during the reallocation process. Workers take wages and the value of search, θ, as given. A worker who is offered a job, makes her decision between working, W, waiting, R, and reallocation, and a worker who cannot work, makes a decision between reallocation and waiting. The value function for inexperienced workers with a job offer at the beginning of production stage is

$$V_{ie,job}(z) = max\{W_{ie}(z), R_{ie}(z), \theta\}$$

$$W_{ie}(z) = w_{ie}(z) + \beta[\alpha EV_e^b(z') + (1-\alpha)EV_{ie}^b(z')]$$

$$R_{ie}(z) = b_r + \beta EV_{ie}^b(z'),$$

where $V_{ie}^b(z')$ gives the value of being an inexperienced worker in the current occupation at the beginning of the next period before the demand shocks are revealed, α is the probability of skill evolution and $V_e^b(z)$ gives the value of being an experienced worker.

The value function for an inexperienced worker who does not have a job is given by

$$V_{ie,nojob}(z) = max\{R_{ie}(z), \theta\},$$

where $R_{ie}(z)$ is the same as before.

Value functions for an experienced worker are similar

$$V_{e,job}(z) = max\{W_e(z), R_e(z), \theta\}$$

[8]This implies that the value functions for experienced workers always take values higher or equal than the value functions for inexperienced workers with a similar job market status(employed or unemployed). This helps the solution of the equilibrium with "seniority rule" since it greatly reduces the potential equilibrium candidates that I have to consider during the computation of the model.

$$V_{e,nojob}(z) = max\{R_e(z), \theta\}$$

$$W_e(z) = w_e(z) + \beta E_t V_e^b(z')$$

$$R_e(z) = b_r + \beta[(1-\gamma)E_t V_e^b(z') + \gamma E_t V_{ie}^b(z')],$$

where γ is the probability of skill loss during the unemployment period.

Note that, given our assumption about the firms' hiring decisions, we can rewrite the beginning of the period value functions as

$$E_t V_i^b(z') \quad = \quad (1-pD)EV_{i,job}(z') + pDEV_{i,nojob}(z'),$$

where $i = \{ie, e\}$. I assume that $b_r < w_{ie}(z)$ for all z. This implies that workers who are offered a job always make their decisions between working and reallocation.

EQUILIBRIUM. Note that, since I assumed linear production function, I can solve the value functions without knowing the distribution of agents over the islands. In other words, I can solve the value functions first and then generate the distribution of workers over islands based on endogenous reallocation decisions implied by value functions, stochastic productivity levels and search technology. Menzio and Shi (2010) call this type of equilibrium a block recursive equilibrium. In models that consider endogenous reallocation across occupations, Carrillo-Tudela and Visschers (2014) also use this type of equilibrium structure in order to consider aggregate and idiosyncratic shocks jointly.

The measure of different types of workers after productivities and demand uncertainty have been revealed in location l, is given by $m = (m_{ie,job}$, $m_{ie,nojob}$, $m_{e,job}$, $m_{e,nojob})$. I also need to define a beginning of the period measure of inexperienced and experienced workers: $m^b = (m_{ie}^b, m_e^b)$. The mapping from m^b to m is trivial, once the demand level is known, that is,

$$m_{i,job} = m_i^b - \delta(Dm_i)$$

$$m_{i,nojob} = \delta D m_i,$$

where $i = \{ie, e\}$ and δ is an indicator function taking the value of 0 if demand is high and of 1 if demand is low. Let us denote this mapping as $m = F(m^b, \delta)$. Next, a mapping from m to $m^{b'}$(measure of workers at the beginning of the next period in location l) is needed. The undirected search implies that in a stationary equilibrium, a constant measure, S, of unemployed occupation switchers, arrives on an island at the beginning of each period. If $g(m,z) = (g_{ie,job},\, g_{ie,nojob},\, g_{e,job},\, g_{e,nojob})$ gives the amount of workers who decided to stay attached in the occupation, we see that

$$m_{ie}^{b'} = (1-\alpha)g_{ie,job} + g_{ie,nojob} + \gamma g_{e,nojob} + S$$

$$m_{e}^{b'} = g_{e,job} + (1-\gamma)g_{e,nojob} + \alpha g_{ie,job}$$

Let us denote this as $m^{b'} = G(m,z)$.

Finally, $P(\delta)$ gives the probabilities for demand states. The equilibrium is as in Kambourov and Manovskii (2009 b) once the block recursive structure and the demand shocks have been taken into account. It can be defined as

1. Given θ and wages, $V_{ie,job},\, V_{ie,nojob}, V_{e,job}\, and\, V_{e,nojob}$ satisfy the Bellman equations above.

2. Wages are determined competitively.

3. Reallocation rules $g_{ie,job},\, g_{ie,nojob},\, g_{e,job}\, and\, g_{e,nojob}$ are implied by the value functions.

   (a) If $V_{ie,nojob}(z) > \theta$, then $g_{ie,nojob}(m,z) = m_{ie,nojob}$, $g_{ie,job}(m,z) = m_{ie,job}$, $g_{e,nojob}(m,z) = m_{e,nojob}$ and $g_{e,job}(m,z) = m_{e,job}$ (No-one reallocates).

   (b) If $V_{ie,nojob}(z) = \theta, V_{ie,job}(z) > \theta$ and $V_{e,nojob}(z) > \theta$, then $g_{ie,nojob}(m,z) = 0$, $g_{ie,job}(m,z) = m_{ie,job}$, $g_{e,nojob}(m,z) = m_{e,nojob}$ and $g_{e,job}(m,z) = m_{e,job}$(all unemployed inexperienced workers reallocate and everyone else stays).

   (c) If $V_{ie,job}(z) = \theta$ and $V_{e,nojob}(z) > \theta$, then $g_{ie,nojob}(m,z) = 0$, $g_{ie,job}(m,z) = 0$, $g_{e,nojob}(m,z) = m_{e,nojob}$ and $g_{e,job}(m,z) = m_{e,job}$ (all inexperienced workers reallocate).

   (d) If $V_{e,nojob}(z) = \theta$ and $V_{ie,job}(z) > \theta$, then $g_{ie,nojob}(m,z) = 0$, $g_{ie,job}(m,z) = m_{ie,job}$, $g_{e,nojob}(m,z) = 0$ and $g(m,z) = m_{e,job}$ (all unemployed workers reallocate).

   (e) If $V_{ie,job}(z) = V_{e,nojob}(z) = \theta$ and $V_{e,job}(z) > \theta$, then $g_{ie,nojob}(m,z) = g_{ie,job}(m,z) = g_{e,nojob}(m,z) = 0$ and $g_{e,job}(m,z) = m_{e,job}$ (all inexperienced and unemployed experienced workers reallocate).

(f) If $V_{e,job}(z) = \theta$, then $g_{ie,nojob}(m, z) = g_{ie,job}(m, z) = g_{e,nojob}(m, z) = g_{e,job}(m, z) = 0$ (all workers reallocate).

4. $G(\cdot)$, that embeds the policy rules together, with $F(\cdot)$, $Q(dz, Z')$ and $P(\delta')$, generates a stationary distribution of islands

$$\mu(M', Z') = \sum_{\delta' \in \Delta'} P(\delta') \int_{(m,z):F(G(m,z),\delta') \in M'} Q(z, Z')\mu(dm, dz),$$

where M' is a set of experience-unemployment distribution, Z' and Δ' are sets of shocks and $Q(dz, Z')$ is the transition function for the productivity shocks.

5. Aggregate employment is given by $E = \int (g_{ie,job} + g_{e,job})\mu(dm, dz)$.

6. Aggregate waiting unemployment is given by $WU = \int (g_{ie,nojob} + g_{e,nojob})\mu(dm, dz)$.

7. The number of agents that search for a new occupation, S, is given by the feasibility constraint $1 = E + WU + S$.

8. The value of search is $\theta = \beta \int V_{ie}^{b}(z)QS(z)$, where $QS(z)$ is the stationary distribution of productivity shocks.

Note that at point 3 of the definition we utilize the fact that perfect substitutability and $b_r < w_{ie}(z)$ for all z imply that $V_{i,nojob} \leq V_{i,job}$ and $V_{ie,j} \leq V_{e,j}$where $i = \{ie, e\}$ and $j = \{nojob, job\}$. The equality only applies when reallocation is optimal. So if, for example $V_{ie,nojob} > \theta \Rightarrow V_{ie,job}(z) > \theta$, $V_{e,nojob}(z) > \theta$ *and* $V_{e,job}(z) > \theta$.

2.2 Economy with a layoff rule that protects experienced workers

Here I describe an economy that is otherwise identical to the one presented in the previous section, but the layoff order in all locations is changed so that experienced workers are more protected against involuntary unemployment spells. The lay-off process starts from inexperienced workers and moves on to experienced workers only if there are not enough inexperienced workers to absorb the demand shock. Within each group (experienced or inexperienced workers present in a certain location), everyone is facing an identical unemployment risk. Given this structure, there are three types of islands. If the demand is high, both inexperienced and experienced (if present) workers are offered a job. When the demand is low and there are enough inexperienced workers to absorb the shock, some inexperienced workers will receive an offer while some will not. All experienced workers (if present) receive a job offer. Finally, if there are not enough inexperienced workers to absorb the demand shock, none of the inexperienced workers are able to work while some experienced workers will get a job offer and some will not.

The layoff process changes the value functions, which now also depend on the distribution of workers,m, since the next periods' unemployment probability is a function of $m^{b'}$. The value functions for different workers are

$$V_{ie,job}(z,m) = max\{W_{ie}(z,m), R_{ie}(z,m), \theta\},$$

$$V_{ie,nojob}(z,m) = max\{R_{ie}(z,m), \theta\},$$

$$W_{ie}(z,m) = w_{ie}(z) + \beta[\alpha E_t V_e^b(z', m^{b}{}') + (1-\alpha) E_t V_{ie}^b(z', m^{b}{}')],$$

$$R_{ie}(z,m) = b_r + \beta E_t V_{ie}^b(z', m^{b'}),$$

$$V_{e,job}(z,m) = max\{W_e(z,m), R_e(z,m), \theta\},$$

$$V_{e,nojob}(z,m) = \{R_e(z,m), \theta\},$$

$$W_e(z,m) = w_e(z) + \beta E_t V_e^b(z', m^{b'}),$$

$$R_e(z,m) = b_r + \beta[(1-\gamma) E_t V_e^b(z', m^{b'}) + \gamma E_t V_{ie}^b(z', m^{b'})].$$

Where

$$E_t V_i^b(z', m') = (1 - pD_i) E_t V_{i,job}(z', m') + pD_i E_t V_{i,nojob}(z', m'),\ i = \{ie, e\}$$

where

$$D_{ie} = min\left\{\frac{D(k_{ie}m_{ie}^{b'} + k_e m_e^{b'})}{k_{ie}m_{ie}^{b'}}, 1\right\}$$

$$D_e = \begin{cases} \frac{D(k_{ie}m_{ie}^{b'} + k_e m_e^{b'}) - D_{ie}k_{ie}m_{ie}^{b'}}{k_e m_e^{b'}} & if\, m_e^{b'} \neq 0 \\ 0 & if\, m_e^{b'} = 0 \end{cases}$$

EQUILIBRIUM. Since the next period's unemployment probabilities now depend on the distribution of workers in that location, the equilibrium is no longer block recursive. That is, agents need to take into account the reallocation rules $g(m,z)$ when making their decisions and individuals' behavior must be consistent with the assumed reallocation rules. Furthermore, actions of inexperienced workers are partly strategic complements, since an inexperienced worker who decided to stay in her current location is usually better off if other inexperienced workers also decided to stay.[9] This allows for a possibility of multiple equilibria. When solving the model, I consider two cases. For the first case, among possible equilibrium candidates during the computational process, I always select the one that leads to the lowest possible mobility. This is an equilibrium candidate that maximizes the present value of production in the current location. In this case, a worker believes that the rest of the workers present on the island that belong to the same group (e.g. unemployed inexperienced) stay put and reallocation in this group only starts if given this belief the worker wants to reallocate. [10] As for the second case, I look at the other extreme equilibrium, where during the computation the candidate that leads to the highest possible mobility is always chosen.

With seniority rules of firing, we need to modify our definition of equilibrium a little relating to parts 1, 3 an 8. Also $D_{ie}$and D_e have to be used in $F(\cdot)$.

1. given θ, wages and policies $g_{i,j}(z,m)$, where $i = \{ie, e\}$ and $j = \{job, nojob\}$, $V_{ie,job}$, $V_{ie,nojob}$, $V_{e,job}$ and $V_{e,nojob}$ satisfy the Bellman equations above

3. The reallocation rules in each occupation are consistent with value functions

   (a) demand is high

      i. If $g_{ie,job}(z,m) = m_{ie,job}$ and $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,job}(z,m) > \theta$.

      ii. If $g_{ie,job}(z,m) < m_{ie,job}$ and $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,job}(z,m) = \theta$ and $V_{e,job}(z,m) > \theta$.

      iii. If $g_{ie,job}(z,m) = 0$ and $g_{e,job}(z,m) < m_{e,job}$, then $V_{e,job}(z,m) = \theta$.

   (b) demand is low and $D_{ie} < 1$

[9] In locations where there are only few experienced workers, this does not always hold true, since a higher amount of inexperienced workers with a job also implies a higher amount of experienced workers present in the next period.

[10] This is an equilibrium that would result if workers would be able to coordinate their actions.

i. If $g_{ie,nojob}(z,m) = m_{ie,nojob}$, $g_{ie,job}(z,m) = m_{ie,job}$ and $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,nojob} > \theta$.

ii. If $g_{ie,nojob}(z,m) < m_{ie,nojob}$, $g_{ie,job}(z,m) = m_{ie,job}$ and $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,nojob} = \theta$ and $V_{ie,job} > \theta$.

iii. If $g_{ie,nojob}(z,m) = 0$, $g_{ie,job}(z,m) < m_{ie,job}$ and $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,job} = \theta$ and $V_{e,job} > \theta$.

iv. If $g_{ie,nojob}(z,m) = 0$, $g_{ie,job}(z,m) = 0$ and $g_{e,job}(z,m) < m_{e,job}$, then $V_{e,job} = \theta$.

(c) demand is low and $D_{ie} = 1$

i. If $g_{ie,nojob}(z,m) = m_{ie,nojob}$, $g_{e,nojob}(z,m) = m_{e,nojob}$, $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,nojob} > \theta$.

ii. If $g_{ie,nojob}(z,m) < m_{ie,nojob}$, $g_{e,nojob}(z,m) = m_{e,nojob}$, $g_{e,job}(z,m) = m_{e,job}$, then $V_{ie,nojob} = \theta$ and $V_{e,nojob} > \theta$.

iii. If $g_{ie,nojob}(z,m) = 0$, $g_{e,nojob}(z,m) < m_{e,nojob}$, $g_{e,job}(z,m) = m_{e,job}$, then $V_{e,nojob} = \theta$ and $V_{e,job} > \theta$.

iv. If $g_{ie,nojob}(z,m) = 0$, $g_{e,nojob}(z,m) = 0$ and $g_{e,job}(z,m) < m_{e,job}$, then $V_{e,job} = \theta$.

8. The value of search θ is given by $\theta = \beta \int V_{ie}^b(z,m)\mu^b(dz,dm)$.

Otherwise the definition is identical to the equilibrium in the previous section.

3 Discussion

Before moving to the calibration and results of the full scale model, it is useful to highlight some of the model properties in a simplified one-island-framework where the outside option, θ, is assumed to be fixed and independent of the different layoff orders. The productivity on the island is constant, subject to only one once-in-a-lifetime change. I assume that the productivity has been so high that before the permanent drop the whole population was working at this location. This implies that there are no incoming workers. Movement between different experience levels during employment and unemployment spells is not possible, i.e., $\alpha = \gamma = 0$.

Given this setup, I look at the size of the productivity drop needed, in order to start the reallocation process for different worker groups when the demand is low. The workers' optimal reallocation policies can be described with reservation wages, i.e., cut-off values that will start the reallocation process.[11] In an equilibrium, reservation wages turn into reservation productivities. Each worker type has its own reservation productivity. Based on the properties of the value functions and assumptions made in the last section, we can conclude that the reservation productivity has to be higher for the unemployed workers compared with the workers who have a job. Inexperienced workers are also more mobile than experienced workers in the sense that experienced workers are willing to accept lower wages per units of human capital than inexperienced workers.

Let us start by looking at the reservation productivities in the economy with an equal unemployment risk. Detailed derivations are available in the appendix. First, assume that the productivity changes permanently into a new level where unemployed inexperienced workers are indifferent between reallocation and staying attached to their current location. Given that $V_{ie,nojob}(z_{ie}^{+}) = \theta$, the value of working takes following form

$$W_{ie}(z_{ie}^{+}) = \frac{z_{ie}^{+}k_{ie} + \beta pD\theta}{1-\beta(1-pD)}.$$

Substituting this into equation $R_{ie}(z_{ie}^{+}) = \theta$ and solving for z_{ie}^{+} gives:

$$z_{ie}^{+} = [\frac{1-\beta}{\beta(1-pD)}\theta - \frac{1-\beta(1-pD)}{\beta(1-pD)}b_r]/k_{ie}.$$

Employed inexperienced workers decide to move out from the island when $V_{ie,job}(z_{ie}^{-}) = W_{ie}(z_{ie}^{-}) = \theta$. Since unemployed workers cannot be better off than employed workers, $V_{ie,nojob}(z_{ie}^{-}) = \theta$. Using these two equations the following threshold productivity is obtained:

$$z_{ie}^{-} = \frac{1-\beta}{k_{ie}}\theta.$$

Note that the reallocation decisions of employed workers do not depend on the unemployment risk. These workers will stay on the island as long as the flow value of working (the wage) is higher than the flow value of reallocation.

[11] In the economy with an equal unemployment risk, these are independent of the beginning of the period masses of experienced and inexperienced workers and all workers in a certain group make identical decisions. In the economy with the "seniority rule", it is not always the case that similar workers end up making identical decisions. However, in the simplified example considered in this section, the economy is a bang-bang one, even with the "seniority rule".

Since the only difference between inexperienced workers and experienced workers is the amount of location specific human capital they have, the cut-off values are also equal once the differences in human capital has been taken into account

$$z_e^+ = [\frac{1-\beta}{\beta(1-pD)}\theta - \frac{1-\beta(1-pD)}{\beta(1-pD)}b_r]/k_e,$$

$$z_e^- = \frac{1-\beta}{k_e}\theta.$$

Next, assume that the society introduces the layoff order considered in section 2.2. Moreover, assume that there are enough inexperienced workers to absorb the demand shock. This implies that there are three types of workers present on the island: unemployed inexperienced, employed inexperienced and employed experienced workers. Since now the unemployment risk tomorrow depends on the distribution of workers present tomorrow,$m^{b'}$, the value functions could also depend on the distribution of workers. As before derivations are available in the appendix. Let us start by looking at the case where no one moves given the beliefs that no-one moves. The lowest possible productivity level for which all worker are willing to stay, $z_{ie}^+(m)$, is such that $R_{ie}(z_{ie}^+(m), m) = \theta$. For this productivity level the value of working can shown to be

$$W_{ie}(z_{ie}^+(m), m) = \frac{z_{ie}^+(m)k(ie) + \beta pD_{ie}\theta}{1-\beta(1-pD_{ie})}.$$

Using this in the equation that equates the value of waiting and the value of reallocation yields to the following threshold value:

$$z_{ie}^+(m) = [\frac{1-\beta}{\beta(1-pD_{ie})}\theta - \frac{1-\beta(1-pD_{ie})}{\beta(1-pD_{ie})}b_r]/k_{ie}.$$

From the previous equation we see that $z_{ie}^+(m)$ is increasing in D_{ie} given that one assumes that the flow value of outside option, $(1-\beta)\theta$, is larger than b_r. This implies that $z_{ie}^+(m)$ is higher if the amount of inexperienced workers today, m_{ie}, relative to the amount of experienced workers today, m_e, is lower.

All inexperienced workers move when productivity takes a value that is smaller than $z_{ie}^-(m)$, where $W(z_{ie}^-(m), m) = \theta$. This threshold value takes familiar form

$$z_{ie}^- = \frac{(1-\beta)\theta}{k_{ie}}.$$

Also in this case, the cut-off productivity for employed inexperienced workers is independent of the probability of unemployment and so it is also independent of the distribution of workers . This holds true as long as we do not allow for the possibility of skill-evolution. In the full-scale model, the reallocation rules for inexperienced workers with a job are not independent of the distribution of workers present on the island. Finally, when $W(z_e^-(m), m) = \theta$, all the inexperienced workers will reallocate, and so the next period, the unemployment risk for an experienced worker is D. Given this, the cut-off rule for experienced workers today is exactly the same as with the case of equal unemployment risk.

Table 1: An illustrative calibration of the simplified model

m_e^b	m_{ie}^b	β	k_{ie}	k_e	p	D	b_r	θ
0.3	0.7	0.99	0.7	1	0.5	0.1	0.2	100

To obtain some idea about the solutions, let us try a calibration presented in Table 1. Without the seniority rule we get the following cut-off values

$$z_{ie}^+ = 1.5009$$

$$z_{ie}^- = 1.4286$$

$$z_e^+ = 1.0506$$

$$z_e^- = 1$$

When $z > z_{ie}^+$, no one is willing to reallocate. When $z_{ie}^- < z < z_{ie}^+$, unemployed inexperienced workers move. When $z_e^+ < z < z_{ie}^-$, all inexperienced workers move. When $z_e^- < z < z_e^+$, all inexperienced and unemployed experienced workers move. If z drops below one, all workers move.

With the "seniority rule", the threshold values for workers are

$$z_{ie}^+ = 1.76$$

$$z_{ie}^- = 1.4286$$

$$z_e^- = 1$$

This simple example illustrates how the "seniority rule" considered in section 2.2 could affect reallocation unemployment. First of all, there is a simple direct channel: more workers with lower cut-off values are being laid off when the waiting unemployment concentrates on the inexperienced workers. The introduction of the "seniority rule" also reduces the cut-off value for inexperienced unemployed workers, implying that smaller productivity changes are likely to trigger the reallocation process. The smaller the amount of inexperienced workers respect to the experienced workers, the larger this channel. In section 5 we will see that even though these channels are present also in the general equilibrium, where movement between skill levels is possible, the effect of human capital accumulation drives the results and reallocation unemployment actually decreases. Finally, note that in order to solve z^{+}_{ie}, I made the assumption that no one is moving and checked what the lowest productivity level consistent with this is. Had I assumed that every inexperienced worker without a job is moving and checked what the highest productivity level consistent with this is, the cut-off value would have been higher than z^{+}_{ie}, since D_{ie} would have been higher.

4 Calibration

The decision of time period used in the model fixes the duration of unemployment spells without reallocation. I set this to three months. This is motivated by the monthly outflow rates of unemployment, without occupational switches, ranging from 0.305 to 0.327, depending on the occupational definition used, reported by Carrillo-Tudela and Visschers (2012). Given the decision of the time period, β is chosen to be consistent with 4% annual interest rate.

The level of human capital for experienced workers, k_e, is normalized to 1. I set $k_{ie} = 0.84$ to be broadly consistent with the OLS estimation results for 1 digit occupational returns reported in Kambourov and Manovskii (2009 a). Based on their results, I also assume that it takes on average 10 years of working for an inexperienced worker to become an experienced one, implying that $\alpha = 0.025$.

It is well documented that unemployment spells are costly not only in terms of foregone wages but also in terms of the re-employment wages which tend to be considerably lower (see, e.g. Jacobson et al, 1993 and Couch and Placzek, 2010). Furthermore, for example, Neal (1995) conditions the wage changes, among other controls, on the industry switch, and shows that in general workers that switch industries suffer greater wage losses. The empirical evidence on wage losses conditional on the occupational tenure and occupational stay, however, is scarce. Carrillo-Tudela and Visschers (2012) report that the median wage changes for prime aged and older workers are about -10%, when there are no occupational changes, while young workers' re-employment wages do not change conditional on occupational stay. According to Kambourov and Manovskii (2009 a), the workers who stay in the same occupation, suffer a 6 % drop in their earnings. I set the probability of skill erosion during unemployment spells without reallocation,γ, to 0.5. This implies that the average wage loss for an experienced worker is 8% if he decides to stay in the same occupation. At the equilibrium where everyone faces an identical unemployment risk, this implies an average loss of 4.5% for those unemployed workers who do not change occupations.

Since I do not allow for the possibility of rest unemployment I have to make sure that workers prefer work over home production at all levels of technology. Following Shimer (2007), I set b_r to 0.4. Identifying D and p is difficult since at the aggregate level we only observe their combination, which, together with the productivity parameters, pins down the waiting unemployment in the economy. In the baseline calibration I fix D to 0.05. Later I explore the sensitivity of my results along this dimension.

The rest of the parameters are chosen so that the model, where all workers face an equal unemployment risk, matches the aggregate unemployment patterns with and without reallocation. I take the model of equal unemployment risk to be representative of the US economy. The motivation for this is twofold. Firstly, the seniority rules used in practice vary a lot between firms and occupations(industries) ranging from clear layoff orders to practices where seniority is one of the many things considered. Moreover, these practices are typically quite different from the layoff rules I am looking at. For example, if firms use some sort of explicit firing order, it relates to the firm tenure not to the occupational experience. Secondly, as unionization has decreased, the use of written rules that protect senior workers has decreased.[12]

I choose the persistence and volatility of the productivity process and the probability of demand shock to match the aggregate unemployment, the fraction of unemployed workers who will find a new job in a new occupation and the fraction of workers who reallocate after they also switched occupation during their previous unemployment spell. The decision of the targets used is motivated by Kambourov and Manovskii (2009 b) who target aggregate mobility and repeated mobility. However, they do not separate between reallocation with and without

[12]For the use of written layoff rules in unionized and non-unionized firms see Abraham and Medoff, 1984.

unemployment, while here I am interested in the responses of the unemployment. From Xiong (2008), we can conclude that a large fraction of occupational switches does not involve unemployment spells. When deciding the empirical targets for reallocation patterns of unemployed workers, I rely on the evidence presented on Carrillo-Tudela and Visschers (2014), who look at the reallocation patterns at the 1 digit level using SIPP data from 1986 to 2011. For all working ages, 50% of the completed unemployment spells involved an occupational switch between major occupational groups. My target for the repeated mobility, 0.56, is also from Carrillo-Tudela and Visschers (2014). The target for aggregate unemployment is 6%. These variables together determine the aggregate reallocation through unemployment, repeated reallocation and unemployment without reallocation. I give an equal weight to each target. When solving the model, I use the discretization method of Tauchen (1986) to approximate the productivity process with a 15 stage Markov process.

Table 2 reports the parametrization used and Table 3 reproduces the targets and shows the model counterparts for the preferred parametrization. From Table 3, it can be seen that our stylized model is able to match the data quite well in terms of aggregate unemployment and the fraction of the unemployed who change occupations. However, the model's ability to match the data when considering repeated mobility is somewhat weaker. It seems that, in reality, the reallocation is a little more persistent than that which the model is able to generate.

Table 2: Parameter values

k_e	k_{ie}	α	γ	p	D	ρ	σ^2	a	β	b_r
1	0.84	0.025	0.5	0.428	0.05	0.977	0.03	0	0.99	0.4

Table 3: Targets and model counterparts

	unemployment	mobility	repeated mobility
targets	0.06	0.50	0.56
model	0.0594	0.50045	0.6133

5 Results

Table 3 assembles the main results. The first column reports the equilibrium statistics for the equal unemployment risk case and the second and third columns give the results for the policy experiment. Low mobility refers to the equilibrium where, during the computation, in the case of multiple equilibrium candidates the one that leads to the lowest reallocation is selected. While high mobility refers to the equilibrium that among potential equilibria leads to the highest possible reallocation.

First of all, looking at the decomposition of unemployment for the benchmark economy, we can see that a little more than 4% of the labor force is in the process of finding a new occupation and 1.90% of the work force is waiting for a job in their current occupation. This means that the majority of unemployment, 68%, is reallocation unemployment. Figure 1 presents the densities of the different types of workers over the productivity levels at the production stage. From the figure it can be seen that experienced workers are staying on islands where inexperienced workers are not willing to stay. This implies that a larger fraction of the inexperienced workers are on the high productivity islands. With the parametrization used, the cut-off productivities for inexperienced workers are same whether they are employed or not. There are, however, islands where the experienced labor force is gradually moving out as demand shocks trigger the reallocation of unemployed workers, while the employed experienced workers stay put.

Comparing the first and second columns in Table 3 and Figures 1 and 2, it can be seen how the stationary equilibrium variables change in the case of low mobility seniority rule equilibrium. It turns out that there is a large drop in unemployment, which is now 4.78 %. This drop comes from the reduced reallocation unemployment, which is reduced from 4.04% to 2.91%, representing 61% of the total unemployment. Contrary to what one could have assumed based on the partial equilibrium analysis, the introduction of the seniority rule practice reduces mobility in the economy. Next, it should be noted that the amount of experienced workers in the economy increases from 57% to 70%. There are, essentially, two interrelated mechanisms that could lead to the reduced mobility and higher aggregate human capital. First, it could be that the workers' incentives to reallocate reduce, i.e. the distributions of different types of workers move towards the lower productivities. Second, when inexperienced workers are laid off first, the amount of exogenous human capital destruction is much

Table 4: Results

	Equal unemployment risk	seniority	
		low mobility	high mobility
S	4.035	2.907	3.504
WU, inexperienced	0.839	1.475	1.446
WU, experienced	1.069	0.397	0.427
total unemployment	5.943	4.779	5.377
m_e^b aggregate	57.008	70.091	69.832
m_{ie}^b aggregate	42.992	29.909	30.168
$g_{e,job}$ aggregate	55.522	69.243	68.978
$g_{ie,job}$ aggregate	38.536	25.978	25.645
aggregate output	101.904	103.507	103.4
Y/N	1.083	1.087	1.093
θ	98.704	99.140	99.014

The size of the population is fixed to 100. Y/N is the average labor market productivity.

smaller than in the case of equal unemployment risk. Given that experienced workers are less mobile, this reduces reallocation unemployment.

It can be seen that both mechanisms are at work. Consistent with the latter explanation, the amount of waiting unemployment for experienced workers is more than 50% lower even though the amount of experienced workers has increased. Comparing the distributions of unemployed experienced workers in Figures 1 and 2 one can see that the new layoff order is mainly protecting human capital in high productivity islands. This occurs since these are locations where inexperienced workers, that now face higher unemployment risk, are willing to stay even though there would be lot of experienced workers present. The next section further highlights this "insurance argument" by exploring how the results react to changes in the human capital depreciation parameter γ.

Looking closer to the reallocation behavior of inexperienced workers reveals that, consistent with the previous partial equilibrium analysis, unemployed inexperienced workers are now pushed out from the islands where they were willing to stay before the new policy. Note, though, that there are still unemployed inexperienced workers willing to stay on islands where productivity is taking the value 1 (the lowest productivity level where unemployed inexperienced workers in an equal unemployment case where still willing to wait for jobs). This, however, requires that there are not too many experienced workers on the island. In fact, some unemployed inexperienced workers are forced away from the islands that have a productivity level of almost 30% higher than the original cut-off value. However, this requires that the unemployment probability is extremely high for future periods. Given the random search and mobility of inexperienced workers, the amount of these types of islands is small and so their contribution to the aggregate equilibrium statistics is small.

Increased mobility of unemployed inexperienced workers is offset by decreased mobility of employed inexperienced workers. These workers are now willing to stay on the islands where they were not willing to stay in the case of an equal unemployment risk. This happens because returns of investment in human capital are now higher since when inexperienced workers become experienced they are likely to spend less time waiting and consequently to stay experienced for a longer period. However, once again inexperienced workers with a job are only willing to stay in these locations given that the distribution of work force is such that the future unemployment risk is not too high. The relative amount of inexperienced workers that decides to reallocate reduces marginally (from 0.084 to 0.081) indicating that an increasing mobility for the unemployed inexperienced workers and a decreasing mobility for the employed inexperienced workers more or less cancel each other.

Finally, turning attention to the reallocation behavior of experienced workers reveals that some unemployed workers are now staying in locations where they were not willing to stay when everybody was treated equally. The reallocation patterns of experienced workers with a job do not change.

There is a substantial increase in waiting unemployment for the inexperienced workers, about 75%. However, the inexperienced workers are not, on average, worse off. The value of θ, which gives the average value of being an inexperienced worker in a randomly picked island at the beginning of a period, actually increases somewhat.

Even though more workers are now staying on "low productivity islands", the effects of increasing human capital dominate the reduced mobility. Production increases by about 1.6% and, unlike in island models without human capital accumulation, reduced mobility does not imply decreasing average labor productivity. The average labor market productivity increases from 1.083 to 1.087.

Figure 1: Worker densities over the productivity levels, equal unemployment probability

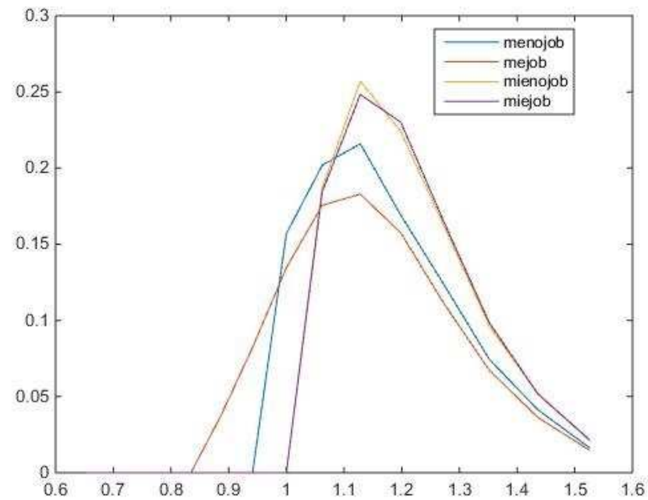
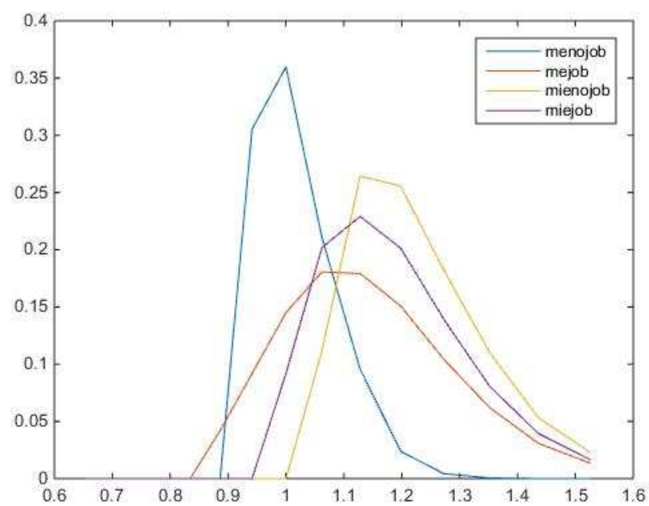


Figure 2: Worker densities over productivity level, seniority rule low mobility



These densities are reported given that the demand is low. The policy rules for high demand are almost identical to the policy rules of low demand given that you are offered a job.

The results reported so far are only related to the stationary equilibrium where workers behaved as if they could co-ordinate their actions within each group. Next, we look at how our results change when we examine the other extreme: a stationary equilibrium where a candidate leading to the highest possible mobility is chosen during the computation process. Comparing columns two and three in Table 4, one can see that the main implications from the policy experiment stay unchanged. The layoff order scheme that protects experienced workers reduces reallocation unemployment and increases the output produced and the aggregate amount of human capital in the economy. However, now 3.5 % of the workers are in the process of finding a new occupation. This is almost 0.6% more than in the case of the low mobility equilibrium. This notably increased mobility does not affect output. In the case of high mobility equilibrium, the output produced increases by about 1.5% relative to the economy with an equal unemployment risk. In the high mobility equilibrium increased unemployment is compensated by the increased productivity. Moreover, the human capital in the economy is more or less as in the low mobility equilibrium. These results imply that even though multiple equilibria can have an important effect for the aggregate amount of reallocation unemployment, increased mobility is mainly taking place in locations where it does not have a large effect on workers' value functions.

6 Sensitivity

In this section, I explore the sensitivity of the results to the calibration and the main driving forces behind the results reported in the last section. I only concentrate on the low mobility equilibrium.

In the previous section, I argued that one of the reasons why occupational mobility via unemployment is decreasing, is because this policy reduces the human capital destruction during the unemployment spells. In order to highlight this, I now explore how the results change when the parameter that governs the human capital destruction during the waiting unemployment, γ, takes different values while other parameters are kept unchanged. Table 5 collects these results. For convenience, the results for the baseline calibration, $\gamma = 0.5$, are also reported in the table. First of all, it can be seen that the speed of human capital depreciation plays an important part in explaining the strong reduction in reallocation unemployment caused by the policy introduction. Even though the workers' incentives to reallocate reduce even when the human capital destruction channel is closed down, since the experienced workers are still spending less time being unemployed in the seniority rule economy, the reallocation unemployment is only reduced by 15.8%. Next, it should be noted that if γ is taking small values, the policy starts hurting the inexperienced workers which is reflected in the reduction of θ. Finally, in order to have a positive effect on the market output at least some human capital depreciation has to take place during the unemployment spells.

Table 5: Relative change of the equilibrium variables between two policies when γ takes different values

γ	0	0.2	0.3	0.5	0.7	0.8
reallocation	-0.158	-0.180	-0.223	-0.280	-0.263	-0.281
unemployment	-0.098	-0.146	-0.175	-0.195	-0.218	-0.228
output	-0.001	0.007	0.010	0.016	0.023	0.026
θ	-0.010	-0.004	0.000	0.004	0.010	0.012

The table reports how the (stationary) equilibrium variables change in relative terms when the economy moves from an equal unemployment risk to a layoff practice where inexperienced workers are laid-off first concentrating on the low mobility equilibrium. The only parameter whose value is allowed to change is the capital depreciation parameter, γ.

In the baseline calibration, the parameter that governs the severity of a demand shock when it strikes, D, was set at 0.05, and the model was calibrated to match aggregate unemployment patterns by allowing the probability of demand shocks to take different values. Next, I explore how sensitive the results are for different values of D by allowing D to take different values while adjusting p so that pD stays unchanged. This should keep the results for the equal unemployment risk unchanged. However, in the "seniority rule" economy the size of D affects the unemployment risk of the experienced workers and so it could alter the equilibrium variables. The results in Table 6 indicate that, for plausible values of D, the effects of the policy change are not sensitive to the exact value of D selected.

Table 6 explores how the results of the policy experiment relate to the parameters governing the productivity process. When convergence to the mean is fast, i.e. ρ takes low values, or variance of innovations is moderate the introduction of "seniority" rule reduces reallocation most.[13] As persistence of the

[13]Obviously with extremely low values of persistence or variance of innovations economies

Table 6: Relative change of the equilibrium variables between two policies when the severity of demand shock, D, is allowed to change while $p * D$ is kept unchanged

D	0.025	0.05	0.1	0.15	0.2
reallocation	-0.274	-0.280	-0.284	-0.254	-0.266
unemployment	-0.203	-0.195	-0.200	-0.185	-0.197
output	0.019	0.016	0.017	0.016	0.013
θ	0.004	0.004	0.006	0.006	0.006

productivity process increases reallocation unemployment increases faster in the seniority rule economy than in the economy where everyone faces an equal unemployment risk. When turbulence of the economy is caused by high values of σ^2, the policy change could even increase reallocation unemployment. This however, only happens when reallocation unemployment is almost as high as the long run average US unemployment rate.

Table 7: Relative change of the equilibrium variables between two policies when ρ or σ^2 takes different values

ρ	0.957	0.967	0.977	0.987
reallocation	-0.385	-0.363	-0.280	-0.064
unemployment	-0.207	-0.230	-0.195	-0.042
output	0.022	0.014	0.016	0.025
θ	-0.006	0.000	0.004	0.002
σ^2	0.02	0.03	0.04	0.05
reallocation	-0.146	-0.280	-0.054	0.076
unemployment	-0.113	-0.195	-0.012	0.062
output	0.022	0.016	0.015	0.012
θ	0.002	0.004	0.003	0.005

7 Conclusions

This paper looked at how a change in the layoff order is capable of affecting reallocation unemployment and whether this could increase the market production and productivity. In order to understand how workers with a different employ-

with an equal unemployment risk and with protection of experienced workers would yield equal reallocation unemployment as returns of reallocation would not be high enough to support occupational mobility.

ment status and a different amount of human capital make their reallocation decisions, a general equilibrium model that combines elements of island models a la Lucas and Prescott with a mismatch type of unemployment was built. It turned out that even though inexperienced workers are more willing to change occupations during unemployment spells, the introduction of a layoff order that concentrates the involuntary unemployment incidences to these workers does not increase the reallocation unemployment in the economy. The baseline calibration indicates that reallocation unemployment drops between 15-28%. This implies that unemployment is reduced by 10-15%. Moreover, in the baseline calibration this decreasing mobility is not associated with decreasing labor market productivity, once the increased human capital has been taken into account. Because of these effects, the output increases by around 1.5% as a result of the introduction of a "seniority rule".

The human capital depreciation during the waiting unemployment plays a major role in generating the results. If the human capital depreciation channel is closed, the reduction in reallocation is halved and the market output decreases marginally. In addition, persistence and variance of innovations in the occupational productivity process are important for the strong reduction of reallocation unemployment.

On a more general level, this paper illustrates that when considering labor market policies, it is important to model how these policies affect the human capital accumulation. Especially if human capital destruction is swift during the unemployment spells, all workers might prefer layoff rules that protect experienced workers. Firms, however, do not consider the cost of unemployment spells in a locally competitive environment and so, might choose to employ socially suboptimal layoff practices. Obviously, there could be reasons, such as a strong complementarity between experience levels or some labor market imperfections, that make firms far from indifferent when it comes to different layoff orders, but these channels should be compared with the human capital effects as these can be non-negligible.

References

[1] Abraham, K. G. and J. L. Medoff (1984): "Length of Service and Layoffs in Union and Nonunion Work Groups" *Industrial and Labor Relations Review*, 38, 87-97.

[2] Alvarez, F. and R. Shimer (2011): "Search and Rest Unemployment," *Econometrica*, 79, 75-122.

[3] Alvarez, F. and R. Shimer (2012): "Unemployment and Human Capital," Mimeo, University of Chicago, USA.

[4] Alvarez, F and M. Veracierto (1999): "Labor Market Policies in an Equilibrium Search Model," *NBER Macroeconomics Annual*, 14, 265-304.

[5] Birchenall, J. A. (2011): "A Competitive Theory of Mismatch," Mimeo, University of Santa Barbara, USA.

[6] Carrillo-Tudela, C. and L. Visschers (2014): "Unemployment and Endogenous Reallocation over the Business Cycle," Working Paper.

[7] Carrillo-Tudela, C. and L. Visschers (2012): "Unemployment and Endogenous Reallocation over the Business Cycle," Working Paper.

[8] Couch, K. A. and Placzek D. W. (2010): "Earning Losses of Displaced Workers Revisited," *American Economic Review*, 100, 572-589.

[9] Heckmann, J. J., R. J. LaLonde and J. A. Smith (1999): "The Economics and Econometrics of Active Labor Market Programs," in *Handbook of Labor Economics*, ed. by O. Ashtenfelter and D. Card, vol. 3A, 1865-2097. Amsterdam: North Holland.

[10] Hopenhayn, H. and R. Rogerson (1993): "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," *Journal of Political Economy*,101,915-938.

[11] Jacobson, L. S., R. J. LaLonde and D. G. Sulivan (1993): "Earnings Losses of Displaced Workers," *American Economic Review*, 83, 685-709.

[12] Kambourov, G. and I. Manovskii (2009 a): " Occupational Specificity of Human Capital," *International Economic Review*,50, 63-115.

[13] Kambourov, G. and I. Manovskii (2009 b): "Occupational Mobility and Wage Inequality," *Review of Economic Studies*,76, 731-759.

[14] Ljungqvist, L. and T., J. Sargent (1998): " The European Unemployment Dilemma" *Journal of Political Economy*,106, 514-550.

[15] Lucas, R. E. Jr and E. C. Prescott (1974): "Equilibrium Search and Unemployment," *Journal of Economic Theory*, 7, 188-209.

[16] Menzio, G. and S. Shi (2010): " Block recursive equilibria for stochastic models of search on the job," *Journal of Economic Theory*, 145, 1453-1494.

[17] Mortensen, D. T. and C. A. Pissarides (1994): "Job Creation and Destruction in the Theory of Unemployment," *Review of Economic Studies*, 61, 397-415.

[18] Neal, D. (1995): " Industry-Specific Human Capital: Evidence from Displaced Workers," *Journal Labor Economics*, 13, 653-677.

[19] Restuccia, D., D. Yang and X. Zhu (2008): "Agriculture and Aggregate Productivity: A Quantitative Cross-Country Analysis." *Journal of Monetary Economics*, 55, 234-250.

[20] Shimer, R. (2007): "Mismatch," *American Economic Review*, 97, 1074-1101.

[21] Shin, D. and K. Shin (2008): "Fluctuations of unemployment and inter- and intra-sectoral reallocation of workers," *International Economic Journal*,22, 231-251.

[22] Sullivan, P. (2010): "Empirical evidence on occupational and industry specific human capital" *Labour Economics*, 17, 567-580.

[23] Tauchen, G. (1986): "Finite state Markov-chain approximations to univariate and vector autoregressions" *Economic Letters*, 20, 177-181.

[24] Wiczer, D. (2013): "Long-Term Unemployment: Attached and Mismatched?" Mimeo, University of Minnesota, USA.

[25] Xiong, H. (2008): "The U.S. Occupational Mobility from 1988 to 2003: Evidence from SIPP" Mimeo, University of Toronto, Canada.

A Derivation of the cut-off productivities

This appendix derives the cut-off productivities shown in section 3. It relies on the fact that both the value of working and that of waiting are continuously increasing in productivity.

A.1 An equal unemployment risk

First, assume that the productivity changes permanently into a new level where unemployed inexperienced workers are indifferent between reallocation and staying attached to their current location. I assumed that working is always preferred over resting, i.e., $W_{ie}(z_{ie}^{+}) > R_{ie}(z_{ie}^{+}) = \theta$:

$$\begin{aligned} V_{ie,job}(z_{ie}^{+}) = W_{ie}(z_{ie}^{+}) &= z_{ie}^{+}k_{ie} + \beta EV_{ie}^{b,}(z_{ie}^{+}) \\ W_{ie}(z_{ie}^{+}) &= z_{ie}^{+}k_{ie} + \beta(1-pD)W_{ie}(z_{ie}^{+}) + \beta pD\theta \\ W_{ie}(z_{ie}^{+}) &= \frac{z_{ie}^{+}k_{ie} + \beta pD\theta}{1-\beta(1-pD)}. \end{aligned}$$

z_{ie}^{+} can then be solved by using the fact that for this productivity level an inexperienced worker is indifferent between waiting and reallocation

$$\begin{aligned} \theta &= R_{ie}(z^{+}) = b_r + \beta(1-pD)W_{ie}(z^{+}) + \beta pD\theta \\ \theta &= b_r + \beta(1-pD)\frac{z^{+}k_{ie} + \beta pD\theta}{1-\beta(1-pD)} + \beta pD\theta \\ \frac{1-\beta}{1-\beta(1-pD)}\quad \theta &= b_r + \frac{\beta(1-pD)}{1-\beta(1-pD)}z^{+}k_{ie} \\ z_{ie}^{+} &= [\frac{1-\beta}{\beta(1-pD)}\theta - \frac{1-\beta(1-pD)}{\beta(1-pD)}b_r]/k_{ie}. \end{aligned}$$

Next, let us find the productivity level when the employed inexperienced workers also decide to move out from the island. This happens when $V_{ie,job}(z^{-}) = W_{ie}(z^{-}) = \theta = V_{ie,nojob}(z^{-})$:

$$\begin{aligned} W_{ie}(z^{-}) &= z^{-}k_{ie} + \beta(1-pD)\theta + \beta pD\theta \\ \theta &= z^{-}k_{ie} + \beta\theta \\ z_{ie}^{-} &= \frac{1-\beta}{k_{ie}}\theta. \end{aligned}$$

Reservation productivities for experienced workers can be derived based on a similar approach.

A.2 A layoff rule that protects experienced workers

Assume that there are enough inexperienced workers to absorb the initial demand shock. This implies that there are three types of workers present on the island: unemployed inexperienced, employed inexperienced and employed experienced workers. Let us start by looking at the case where no one moves. Moreover, we assume that workers believe that no one moves and the reallocation only starts when, given this belief, a worker with the lowest value of remaining (an inexperienced worker without a job) finds it optimal to reallocate. The lowest possible productivity level ,$z_{ie}^{+}(m)$, when all workers are willing to stay, is such that $R(z_{ie}^{+}(m),m)=\theta$. For this productivity level

$$\begin{aligned} V_{ie,job}(z_{ie}^{+}(m),m) &= W_{ie}(z_{ie}^{+}(m),m) \\ &= zk_{ie}+\beta(1-pD_{ie})W_{ie}(z_{ie}^{+}(m),m')+\beta pD_{ie}\theta. \end{aligned}$$

Note that m' is not necessarily the same as m since demand levels can be different. However, $m^b$and unemployment probabilities will stay the same for all periods since no one leaves and there is no movement between the different skill levels. This implies that the value of working will stay unchanged.

$$W_{ie}(z_{ie}^{+}(m),m)=\frac{z_{ie}^{+}(m)k(ie)+\beta pD_{ie}\theta}{1-\beta(1-pD_{ie})}.$$

Given this, we can solve the threshold productivity by equating the value of waiting and the value reallocation:

$$\theta=R_{ie}(z_{ie}^{+}(m),m)=b_r+\beta(1-pD_{ie})W_{ie}(z_{ie}^{+}(m),m)+\beta pD_{ie}\theta$$

$$z_{ie}^{+}(m)=[\frac{1-\beta}{\beta(1-pD_{ie})}\theta-\frac{1-\beta(1-pD_{ie})}{\beta(1-pD_{ie})}b_r]/k_{ie}.$$

All inexperienced workers move when productivity takes a value that is smaller than $z_{ie}^{-}(m)$, where $W(z_{ie}^{-}(m),m)=\theta$.

$$\begin{aligned} \theta &= z_{ie}^{-}(m)k_{ie}+\beta(1-p)V_{ie,job}(z_{ie}^{-}(m),m')+\beta p(1-D_{ie})V_{ie,job}(z_{ie}^{-}(m),m') \\ &\quad +pD_{ie}V_{ie,nojob}(z_{ie}^{-}(m),m') \end{aligned}$$

$$\theta=z_{ie}^{-}k_{ie}+\beta\theta$$

$$z_{ie}^{-}=\frac{(1-\beta)\theta}{k_{ie}}.$$

The **Aboa Centre for Economics (ACE)** is a joint initiative of the economics departments of the Turku School of Economics at the University of Turku and the School of Business and Economics at Åbo Akademi University. ACE was founded in 1998. The aim of the Centre is to coordinate research and education related to economics.

Contact information: Aboa Centre for Economics, Department of Economics, Rehtorinpellonkatu 3, FI-20500 Turku, Finland.

www.ace-economics.fi

ISSN 1796-3133