A Positive Theory of Geographic Mobility and Social Insurance *

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Abstract

This paper presents a tractable dynamic general equilibrium model that can explain cross-country empirical regularities in geographical mobility, unemployment and labor market institutions. Rational agents vote over unemployment insurance (UI), taking the dynamic distortionary effects of insurance on the performance of the labor market into consideration. Agents with higher cost of moving, i.e., more attached to their current location, prefer more generous UI. The key assumption is that an agent's attachment to a location increases the longer she has resided there. UI reduces the incentive for labor mobility and increases, therefore, the fraction of attached agents and the political support for UI. The main result is that this self-reinforcing mechanism can give rise to multiple steady-states – one "European" steady-state featuring high unemployment, low geographical mobility and high unemployment insurance, and one "American" steady-state featuring low unemployment, high mobility and low unemployment insurance.

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1 Introduction

Europeans are substantially less mobile than Americans. For instance, in the early 90's, the yearly rate of migration across U.S. states was 3.2%, while the rate of regional migration was 1.3-1.4% in Germany and France, and 0.6% in Italy and Spain.[1] Regional migration in Japan, Canada, U.K. and Australia is larger than in continental Europe, but smaller than in the U.S. Across countries, migration rates are negatively correlated with national unemployment rates. Figure 1a plots yearly internal migration rates vs. standardized OECD unemployment rates from 1980 to 1995 (five-year interval observations) for the nine largest OECD countries; Australia, Canada, France, Germany, Italy, Japan, Spain, the U.K. and the U.S., showing that high-mobility countries are, on average, characterized by lower unemployment (with a coefficient of linear correlation equal to -0.5).[2]

Earlier micro studies confirm that migration decisions are closely related to unemployment and job mobility. For instance, Bartel (1979) documents that the proportion of moves in the U.S. caused by the decision to change jobs is one-half of all migration decisions for young workers and one third of all migration decisions for workers above the age of 45. Similarly, DaVanzo (1978) and Pissarides and Wadsworth (1989) document that unemployment significantly increases the likelihood of migration both in the U.S. and the U.K.[3] Other studies find that the internal migration responds significantly to temporary regional shocks in the U.S. but not in Europe. In particular, Blanchard and Katz (1992) find that regional shocks give rise to large responses in cross-state migration in the U.S., whereas Decressin and Fatás (1995) find that the same type of shocks generate insignificant migration in Europe, where the main response comes through changes in regional labor participation and

[1] The differences are even larger considering that the average U.S. state is larger than the corresponding regions in the Europan countries. In terms of average population, the size of a state in the U.S. is 5.2 millions versus 5.1 millions for Germany, 2.6 millions in France, 2.9 millions in Italy and 2.3 millions in Spain. Similarly, the average geographical size of a U.S. state is much larger than that of a German region, for instance.

[2] The rates of regional migration are from the OECD (2000), Table 2.10. We have omitted the observations for smaller OECD countries for which data are available (in particular, Belgium, Finland, the Netherlands, Portugal and Sweden) since the regional units are substantially smaller, either in territorial size or population, than those of larger countries, making the notion of regional mobility difficult to compare. Their inclusion would not alter the statistics of interest, however The correlation between mobility and the unemployment rate remains negative (-0.37). The correlation between unemployment insurance and mobility is also negative (-0.53), whereas the correlation between unemployment benefits and unemployment rates is positive (0.32).

[3] More recently, McCormick (1997) has documented that the high unemployment rate of manual workers in the U.K. is due to their relatively low mobility.

unemployment.

Cultural and language barriers can help explain why Europeans do not move across countries, but they do not explain the low rate of regional migration within countries. Institutions are therefore likely to play an important role. This paper argues that the generosity of the unemployment insurance (UI) system is an important factor in explaining the puzzle. If mobility is costly, agents who are well insured against the risk of unemployment will have a lower incentive to move to regain employment. This argument is consistent with the evidence of a large negative cross-country correlation between mobility rates and the generosity of UI. Figure 1b plots yearly internal migration rates vs. unemployment insurance for the same sample as figure 1a.[4] As the figure shows, high-mobility countries like Japan and the U.S. are characterized by low UI, whereas low-mobility countries like France, Spain and Germany have the most generous insurance systems (the correlation is -0.68).[5] Finally, figure 1c shows that unemployment rates are positively correlated with the generosity of the insurance systems, the correlation being 0.59.

In this paper, we construct a tractable dynamic general equilibrium model accounting for these facts. The main contribution of the theory is to endogenize the choice of unemployment insurance and its interaction with labor market performance. Namely, we do not take differences in policies and institutions as exogenous, but explain them as the outcome of a stylized political mechanism where rational agents vote over the insurance policy, taking the dynamic effects of UI on the performance of the labor market into consideration.

Our theory has two main building blocks. First, the attitude towards migration is path dependent. The longer an agent lives in a particular location, the stronger is her attachment to that location, either due to friendships, family ties, etc., or to the accumulation of location-specific human capital that is lost when the worker moves. A number of studies (Borjas et al. (1992), Krieg (1997)) have documented that migrants experience a temporary reduction of earnings after a move, although this is later followed by high wage growth.

[4] Unemployment insurance is measured by the summary measure provided by the OECD Data-base on Benefit Entitlements and Gross Replacement Ratios.

[5] Italy is the main outlier. In Italy, the unemployment insurance system is among the least generous for the countries in the sample, yet, mobility is very low. It should noticed, however, that high unemployment areas in the South of Italy have been the target of a large flow of regional transfers. Brunello et al. (1999) find that these subsidies significantly reduced the South-North mobility. Note that our sample only includes one observation for Italy, due to lack of comparable measures of benefits for earlier years. For Spain, Bentolila (1997) argues that institutional factors have significantly contributed to the slowdown of mobility since the 1970's. In particular, he mentions the increase in both the duration and coverage of unemployment benefits, together with other regional transfers and social policy.

Figure 1: Geographical mobility, unemployment rates and unemployment insurance in the 9 largest OECD countries.

Together with pecuniary and non-pecuniary set-up costs (e.g., housing transactions, cultural assimilation), this reduces the attractiveness of migration. Empirical studies confirm the role of path dependence by documenting that the length of residence in the current location is a major determinant of the probability of migration (Kaluzny (1975), DaVanzo (1978), and Bartel (1979)).[6]

The other building block of our theory is that the attitude towards mobility interacts with social preferences for publicly provided unemployment insurance, creating a self-reinforcing mechanism. In a low-mobility society where more workers perceive migration as costly, there will be a stronger political demand for unemployment insurance. Unemployment insurance, in turn, deters mobility, implying that more agents get attached to their locations, which ensures that the demand for UI is sustained over time. Our main result is that a "European" steady-state featuring high unemployment, low migration and high unemployment insurance can co-exist with an "American" steady-state featuring low unemployment, high migration and low unemployment insurance.

The model economies are characterized by search frictions in the labor market and mobility costs (close in spirit to Diamond (1981)). Workers differ in their attachment to the location where they live, and attachment grows stochastically with the length of residence (for simplicity, we capture heterogeneity by assuming individuals to be either attached or unattached). Attached workers face higher mobility costs and are less likely to move. Migration is assumed to occur only to escape unemployment. In particular, workers are stochastically laid-off. To simplify the analysis, we restrict the attention to "voluntary unemployment", and assume that a displaced worker can always be re-employed within the period if she is willing to move when laid off. If she does not to want to migrate, however, she faces a constant probability of receiving no job offer and remaining unemployed.

An important assumption in our analysis is that the moving cost cannot be fully insured by the government. We motivate this formally by assuming that individual attachment is unobservable. We regard this assumption to be reasonable since the moving costs consist of several individual specific components, some psychological some monetary, etc., many of which are difficult to objectively quantify.

[6] According to Bartel (1979), part of this observation is due to the correlation between job tenure and length of residence. Since the probability of job separation decreases with tenure, workers who have been resident in a certain location for a longer period of time suffer a lower probability of job separation. In our theory, we assume, for simplicity, that job tenure has no effect on the probability of separation. Tenure dependence in separation rates, however, would only reinforce the results of our model, as long as this is due to accumulation of human capital with a location specific component.

In contrast to attachment, we assume that the government can observe whether an individual is employed or not. Given this simplified description of the labor market flows, we study the political determination of UI. The median voter is realistically assumed to be employed. Yet, since agents are risk averse and markets are incomplete, the UI system provides insurance to employed workers, and a political demand for such system may arise. Not all employed workers value UI to the same extent, though. For unattached workers, moving is less costly (in fact, we make the simplifying assumption that moving is completely costless for them). They still attribute a positive value to UI in anticipation of possibly becoming attached in the future. But, since future utility is discounted, unattached workers value UI less than attached workers.

The size of groups is assumed to determine their political influence via a standard majority voting mechanism. Thus, economies populated by a majority of attached workers (Europe) will demand more UI than economies populated by a majority of unattached workers (the U.S.). A generous UI system, in turn, deters mobility, by making unemployment less costly to the individual, and increases the proportion of attached workers in the society. The self-reinforcing interaction between attachment and preferences for UI can give rise to multiple steady-states. In particular, two economies populated by agents with identical preferences but different distributions of labor market characteristics may end up choosing very different degrees of social insurance, implying different migration rates and labor market performance. Moreover, these differences are self-sustained.

The result that multiple steady-states can exist is neither *a priori* obvious, nor is it true in general. There are in fact two forces playing in opposite directions. On the one hand, the fact that, due to its effect on search behavior, high UI tends to make the median voter more strongly geographically attached creates a self-reinforcing mechanism which tends to generate multiple steady-states. On the other hand, insurance is more expensive (i.e., less actuarially fair) for employed workers when there is a large initial stock of unemployed workers. This effect strengthens the political support for UI in an "American" situation, relative to that of a "European" one, and plays against the self-reinforcing mechanism generating multiple steady-states. Which effect dominates depends on parameters and our analytical results pin down the exact parameter conditions for multiplicity to arise.

We then calibrate a version of the model that allows for consumption smoothing through savings. More precisely, we use data on mobility and unemployment to calibrate all parameters except for moving cost and risk aversion, and then compute which combinations of moving cost and risk aversion give rise to multiplicity. We find that the parameters required for multiplicity seem empirically reasonable.

Naturally, this paper does not argue that UI generosity is the only institutional factor accounting for differences in labor market performance and mobility. For instance, Bover et al. (1989), Cameron and Mullbauer (1998 and 2000) and Oswald (1997 and 1999) emphasize the importance of the structure of home-ownership. Oswald (1997) argues that the share of owner-occupied housing increases unemployment by deterring mobility. To the extent that UI affects the choice of house ownership, these ideas reinforce our argument, because the purchase of a house is a sunk investment that further increases the cost of mobility. Moreover, factors outside our model framework affecting house ownership (such as the quality of credit markets), can be interpreted as exogenous variations in mobility costs across countries. Not surprisingly, our model predicts that countries with high exogenous barriers to mobility tend to be characterized by a unique European steady state, whereas countries with low barriers tend to be characterized by a unique American steady state. Our endogenous policy mechanism is nevertheless operative, however, by magnifying small exogenous differences into large differences in social insurance and labor market allocations.

Our paper relates to a growing stream of theoretical literature on UI and labor market performance. The argument that unemployment insurance is an important factor in explaining the large differences in unemployment rates and earnings inequality observed in Western Europe and the United States during the last quarter of the twentieth century is found, for instance, in Ljunqvist and Sargent (1998), Marimon and Zilibotti (1999), and Mortensen and Pissarides (1999). Other papers have argued that UI affects the quality of the jobs created, with a non-monotonic effect on output and efficiency (see Acemoglu (2001) and Acemoglu and Shimer (1999)). This literature treats UI as an exogenous institution, and only few authors have attempted to build a positive theory explaining why such different UI levels are observed across countries. The first paper to explore this idea is Wright (1986), which analyzes the trade off between transfer and insurance effects when employed workers decide about the UI level. More recent papers on the political economy of UI include Hassler and Rodríguez Mora (1999) , Pallage and Zimmermann (2001) and Saint Paul (1993, 1996 and 1997). None of these papers focuses on the effects of insurance on geographical mobility, however. More important, the novelty of our approach with respect to this literature is that (i) we take into explicit consideration the two-way relationships between labor market flows and UI policy, and (ii) the general equilibrium nature of our analysis allows us to calibrate the parameters of the model and study the implications of the theory from a quantitative perspective.

The paper is organized as follows. In section 2, we describe the model environment. In section 3, we define the equilibrium search behavior with an exogenous UI. In section

4, we define characterize the political equilibrium analytically under the assumption that agents vote once-and-for all over constant benefit sequences. We provide conditions such that multiple steady-states exist. In section 5, we extend the model to allow for saving and borrowing, and show that the main results of the model carry over to this more realistic case. We also calibrate the parameters of the model in order to match a set of empirical observations on labor market performance and migration rates in Europe and the U.S. The result is that the region of the parameter space where multiple steady-states are sustained contains realistic parameterizations. Section 6 concludes and discusses extension.

2 Model environment

2.1 Preferences

The model economy is assumed to be populated by a continuum of infinitely lived risk averse workers, whose preferences induce constant absolute risk aversion (CARA). Formally, an agent maximizes

$$-E_t \sum_{s=0}^{\infty} (1+\rho)^{-s} e^{-\sigma\left(c_{t+s}-\zeta_{t+s} z\right)}, \tag{1}$$

where σ is the coefficient of absolute risk aversion, c_t denotes consumption, z parameterizes the disutility of moving and $\zeta \in \{0,1\}$ is an indicator variable that takes the value one if a worker moves from a location to which she is attached, and zero otherwise.

A worker's labor income, paid at the end of each period, consists of a wage w if she works and unemployment benefits $b \in [0, w]$ if she is unemployed. Taxes are levied lump sum, implying that the disposable income is $w - \tau$ for an employed worker and $b - \tau$ for an unemployed worker. In this section, we assume that agents do not have access to capital markets, i.e., they can neither borrow nor save. This simplification is made for presentational purposes. We will later extend the model by endogenizing the saving decision (section 5) and show that the qualitative results remain unchanged.

The economy has a large number of identical locations where job opportunities arise. Workers are heterogenous in terms of their employment status (*employed* or *unemployed*) and the degree of attachment to the location where they live (*attached* or *unattached*). Workers move in and out of employment. In particular, employed workers face a constant probability of being laid off and unemployed workers face an invariant distribution of job offers. More precisely, job searchers receive a job offer in the location where they currently live with probability π and only in other locations with probability, $1-\pi$. Attachment has no effects on the productivity of a worker. The only difference is that an attached worker suffers a cost z when moving to a different location, whereas an unattached worker suffers no such cost.[7]

The timing is as follows;

1. A fraction $\gamma/(1-\pi)$ of the workers are laid off.

2. All job searchers, including those just laid off, receive a job offer. A share π receive an offer in their own current location and the remaining $1-\pi$ receive job offers only from other locations.

3. A fraction α of the unattached employed workers become attached to their current location.

4. Outstanding job offers are accepted or rejected. Whenever an attached worker moves, she pays a cost z out of her income in the new job and becomes unattached. Attached workers, both employed and unemployed, who stay, remain attached. Clearly, all job offers raised "at home", as well as all job offers raised "abroad" by unattached workers are accepted. The only non-trivial economic decision is made by attached unemployed who only receive an offer abroad, as they face a trade-off between paying a moving cost z and becoming unemployed.

5. Wages and unemployment benefits are paid, taxes collected and consumption takes place.

More formally, let the labor market status of an agent be denoted by ω and the set of possible labor market states by $\Omega \equiv \{a, n, u\}$, where a stands for attached employed workers, n stands for unattached employed workers and u stands for unemployed workers. Note that there are three labor market states only when individuals are rational, since all unattached workers who are laid off can find a new job immediately and without costs. An agent's labor market status follow a Markov process, with a transition matrix

$$\Gamma(\nu) \equiv \begin{bmatrix} 1-\gamma & \gamma\nu & \gamma(1-\nu) \\ \alpha & 1-\alpha & 0 \\ \pi & \nu(1-\pi) & (1-\pi)(1-\nu) \end{bmatrix}, \tag{2}$$

[7] We will interpret these as geographical locations. Note, however, that an alternative interpretation might be to regard locations as sectors of activity and attachment as sector-specific human capital.

where γ is the probability that a worker is laid-off and not immediately rehired in her own location, and α is the probability that an unattached workers becomes attached. The variable $\nu \in \{0, 1\}$ describes the moving choice of attached workers. In particular, $\nu = 0$ describes a selective strategy, i.e., wait for an offer at home rather than migrating, whereas $\nu = 1$ describes a nonselective strategy, i.e., migrating whenever no job is offered at home. Note that the decision of an attached worker who has just been laid off is identical to that of a worker already in the unemployment pool.[8]

Displaced attached employed workers (first row) and unemployed workers (third row) become unemployed if they follow a selective search strategy, $\nu = 0$, whereas they move and become employed unattached if they follow the nonselective strategy, $\nu = 1$ (first row). Unattached workers remains unattached with probability $1 - \alpha$ and become attached with probability α (second row). Under no circumstance, they become unemployed.

2.2 Distribution of employment and attachment

The aggregate state of the economy is described by the distribution of agents across labor market states, defined by attachment and employment status. More formally, let the vector $\mu_t = (a_t, n_t, u_t) \in R^3_+$, where $a_t + n_t + u_t = 1$, describe such distribution at time t. The focal point of our model is the search behavior of the attached displaced workers. Conditional on a time-invariant search behavior ν, the law of motion of the distribution of agents, μ_t, is entirely deterministic and given by:[9]

$$\mu_t = \mu_{t-1}\Gamma(\nu) \tag{3}$$

The long run distributions conditional on ν, $\mu^s(\nu)$, are given by the eigenvector associated with the matrix $\Gamma(\nu)$, i.e., $\mu^s(\nu) = \mu^s(\nu)\Gamma(\nu)$, where $\mu^s(\nu) \cdot e = 1$. In particular, we

[8] A laid off attached employed worker who is offered a job in another location earns $w - z$ in the current period if taking that job offer, and b if rejecting it and going into unemployment. Similarly, a worker who starts the period by being unemployed and is offered a job opportunity abroad earns $w - z$ if taking it, and b if rejecting it. For both workers, mobility implies losing their attachment. Thus, their decision problems are identical.

[9] With some abuse of notation, ν defines both the individual search strategy and the aggregate search behavior governing the distribution of characteristics in the population. As we will see, however, individually optimal search behavior is independent of aggregate search behavior. Our parsimonious representations entails, therefore, no loss of generality.

obtain:

$$\mu^s(0) = \left\{\frac{\pi}{\gamma+\pi}, 0, \frac{\gamma}{\gamma+\pi}\right\}$$
$$\mu^s(1) = \left\{\frac{\alpha}{\gamma+\alpha}, \frac{\gamma}{\gamma+\alpha}, 0\right\}.$$

Consider first $\mu^s(0)$. Under selective search behavior, all agents are attached in the long-run. Since no attached agent ever pays the moving cost and becomes unattached, there is no inflow into the group of unattached employed workers, whereas there is some outflow, as α unattached workers become attached in every period. Next, consider $\mu^s(1)$. Under nonselective search behavior, no agent ever becomes unemployed, and the long-run distribution features a positive proportion of employed agents only. We interpret this feature of the model as implying that, if agents are nonselective, there is no structural unemployment. While some agents are laid off and transit from one job into another in every period, the unemployment spell during this transition is shorter than a period. Thus, frictional unemployment is excluded by the accounting of our model.

Throughout, we maintain the following parameter restrictions;

Assumption 1 $0.5 > \pi > \gamma > \alpha$.

The assumption that all parameters are smaller than one half ensures that labor states are persistent. The assumptions that $\pi > \gamma$ and $\gamma > \alpha$ ensure that the attached employed and unattached employed are in majority in each of the two long run distributions, $\mu^s(0)$ and $\mu^s(1)$.

3 Equilibrium search behavior

Given the model environment, we proceed to analyze the agents' private decisions. In particular, we treat benefit rates as exogenous and time invariant and analyze their effect on search behavior. Taxes and benefits are constant over time and interdependent through the government's budget constraint. For tractability, we assume that the government can perfectly smooth tax rates by running temporary deficits or surpluses, financing them by international capital market operations. This allows us to explicitly consider transitional dynamics. The government's intertemporal budget constraint implies that the present discounted value of government revenues and expenditures must be equal. Government revenues consist of lump sum taxes, while the expenditures consist of transfers to the unemployed. For simplicity, we assume that the interest rate faced by the government is equal to the discount rate of private agents.

The tax rate balancing the government's intertemporal budget is denoted $\tau(b, \mu_0, \nu)$, where b is a benefit rate, μ_0 is an initial distribution and $\nu \in \{0, 1\}$ is a time-invariant aggregate search behavior. Clearly, if $\nu = 1$, there are no transfers. Thus, $\tau(b, \mu_0, 1) = 0$. If $\nu = 0$, however, $\tau(b, \mu_0, 0) = T(\mu_0)b$, where

$$\begin{aligned} T(\mu_0) &\equiv \frac{\rho}{1+\rho}\sum_{t=0}^{\infty}(1+\rho)^{-t} u_t(0, \mu_0) \\ &= \frac{\gamma}{\pi+\gamma} + \left(u_0 - \frac{\gamma}{\pi+\gamma}\right)\frac{\rho}{\rho+\pi+\gamma} - n_0\frac{\gamma\rho}{(\rho+\alpha)(\rho+\pi+\gamma)}, \end{aligned} \tag{4}$$

and $u_t(0, \mu_0)$ denotes the unemployment rate at time t when agents search selectively and the initial distribution is μ_0. More formally, $u_t(0, \mu_0)$ is the third component of the vector $\mu_t \equiv \Gamma(0)^t\mu_0$, where $\Gamma(0)$ is defined by (2). The second equality is obtained by solving the system of difference equations (3) under selective behavior ($\nu = 0$). $T(\mu_0)$ can be interpreted as the average discounted unemployment rate, which increases with the initial share of unemployed and decreases with the initial share of unattached.

The value functions for each state $\omega \in \Omega$, conditional on search behavior ν, taxes τ and benefits are given by:[10]

$$\begin{aligned} V_\omega(\nu, \tau, b) &= -(1+\rho)e^{\sigma\tau}\left(e^{-\sigma w} + (1-\nu)P_{\omega,0}\left(e^{-\sigma b} - e^{-\sigma w}\right)\right. \\ &\quad \left. +\nu P_{\omega,1}\left(e^{-\sigma(w-z)} - e^{-\sigma w}\right)\right), \end{aligned} \tag{5}$$

where

$$\begin{aligned} P_{\omega,0} &= \frac{\rho}{1+\rho}\sum_{t=0}^{\infty}(1+\rho)^{-t}\cdot \text{Prob}(\omega_t = u|\omega_0 = \omega, \nu = 0), \\ P_{\omega,1} &= \frac{\rho\gamma}{1+\rho}\sum_{t=1}^{\infty}(1+\rho)^{-t}\cdot \text{Prob}(\omega_{t-1} = a|\omega_0 = \omega, \nu = 1). \end{aligned}$$

$P_{\omega,0}$ can be interpreted as the *average discounted probability* (ADP) of being unemployed, conditional on a selective search strategy and an initial state $\omega \in \{a, n, u\}$. Similarly, $P_{\omega,1}$ is the ADP of paying the moving cost conditional on a nonselective search strategy and an initial state $\omega \in \{a, n, u\}$.[11] The exact expressions of these ADP's are provided in appendix 7.1.

[10] See appendix 7.1 for details.

[11] Since the probability that an employed worker will move at a future date t equals $\gamma\cdot\text{prob}(\omega_{t-1} = a)$, then, $P_{\omega,1} = (1-\beta)\sum_{t=1}^{\infty}(1+\rho)^{-t}\gamma\cdot\text{prob}(\omega_{t-1} = a|\omega_0 = \omega, \nu = 1)$ for $\omega \in \{a, n\}$. For unemployed workers, $P_{u,1} = (1-\beta)(1+\beta P_{n,1})$.

We can now provide a formal definition of an equilibrium search behavior (ESB). The ESB simply defines the optimal search behavior of attached workers, since these are the agents who make nontrivial choices as discussed above.

Definition 1 *An* ***equilibrium search behavior (ESB),*** $\nu^*(b,\mu_0) \in \{0,1\}$, *is defined by* $\nu^*(b,\mu_0) = \arg\max_{\nu\in\{0,1\}} V_a(\nu,\tau(b,\mu_0,\nu),b)$. *In the case of indifference, behavior is assumed to be non-selective, i.e.* $\nu^*(b,\mu_0) = 1$.

It should be noted that $\arg\max_{\nu\in\{0,1\}} V_\omega(\nu,\tau(b,\mu_0,\nu),b)$ is the same for all $\omega \in \{a,n,u\}$. Furthermore, since all value functions are proportional to $e^{\sigma\tau}$, the ESB is independent of the tax-rate. More formally, for any τ,τ', $\arg\max_{\nu\in\{0,1\}} V_\omega(\nu,\tau,b) = \arg\max_{\nu\in\{0,1\}} V_\omega(\nu,\tau',b)$. This property, which is due to the assumption of CARA utility, simplifies the characterization of the ESB, summarized in the following proposition:

Proposition 1

1. *For any* (b,μ_0), *there exists a unique ESB,* $\nu^*(b,\mu_0) \in \{0,1\}$.
2. *Let* $\bar{b} = w - \frac{1}{\sigma}\ln\left(1 + \frac{P_{a,1}}{P_{a,0}}\left(e^{\sigma z}-1\right)\right)$. *(A) If* $\bar{b} < 0$, *then* $\nu^*(b,\mu_0) = 0$ *for all* $b \in [0,1]$. *(B) If* $\bar{b} \geq 0$, *then* $\nu^*(b,\mu_0) = 1$ *for all* $b \leq \bar{b}$ *and* $\nu^*(b,\mu_0) = 0$ *for all* $b > \bar{b}$.

The proposition follows immediately from (5); if $P_{a,0}\left(e^{-\sigma b} - e^{-\sigma w}\right) > (<)$ $P_{a,1}\left(e^{-\sigma(w-z)} - e^{-\sigma w}\right)$, then $\nu = 0$ ($\nu = 1$) is optimal. Apart from trivial cases where selective behavior is always optimal (e.g., prohibitive mobility costs, see part 2A of the Proposition), the equilibrium has threshold properties; for insurance above (below) a certain level $\bar{b}$, selective (nonselective) behavior is optimal. Note that the threshold is increasing in w and decreasing in z. Finally, note that, under full insurance ($b = w$), selective behavior is always optimal.

4 Political Equilibrium

So far, the benefit rate has been taken as exogenous. In this section, we determine b as the endogenous outcome of a political mechanism, based on majority voting. The main result is that multiple steady-states can be sustained. In particular, two economies with identical parameters but different initial distributions may end up, respectively, in a steady-state with high benefits, low mobility and high unemployment or in a steady-state with no benefits, high mobility and low unemployment. In the benchmark case studied in this section, agents vote once-and-for-all for a constant sequence of benefits (implying a constant sequence of tax rates). In this environment, we obtain transparent analytical results. In the concluding section, we discuss the extension of the analysis to an environment characterized by repeated voting, where agents vote over benefit rates in each period, and the government budget must balance on a period-by-period basis. While dynamic voting complicates the analysis, the main results of the paper carry over to this extension.

We now introduce a definition of Political Equilibrium, conditional on the existence of a politically *decisive* agent (or group). Note that if the initial distribution is a steady-state (either $\mu^s(0)$ or $\mu^s(1)$), the existence of a decisive voter is not an issue, as absolute majorities exist.

Definition 2 *A* ***political equilibrium****, conditional on an initial distribution* μ_0*, is an allocation* $\{\nu^*, \tau^*, b^*\}$ *such that:*

1. *All agents choose search policies maximizing their expected discounted utility, i.e.,* $\nu^* = \nu^*(b^*, \mu_0)$ *is an ESB.*

2. *The tax rate balances the intertemporal government budget constraint, i.e.,* $\tau^* = \tau(b^*, \mu_0, \nu^*)$.

3. *The politically decisive agent sets* b^* *so as to maximize her expected discounted utility, i.e.,* $b^* = \arg\max_b \tilde{V}_d(b, \mu_0)$*, where* $\tilde{V}_d$ *denotes the value function of the politically decisive agent, incorporating the equilibrium search behavior, i.e.* $\tilde{V}_\omega(b, \mu_0) \equiv V_\omega(\nu^*(b, \mu_0), \tau(b, \mu_0, \nu^*(b, \mu_0)), b)$.

Definition 3 *A* ***steady-state political equilibrium (SSPE)*** *is a political equilibrium with the additional requirement that* $\mu_0 = \mu^s(\nu^*(b^*, \mu_0))$*, i.e.,* μ_0 *is the ergodic distribution associated with the ESB* $\nu^*(b^*, \mu_0)$.

According to Definition 2, the equilibrium benefit rate, b^*, maximizes the utility of the politically decisive group at time zero. The assumption of once-and-for-all voting may be regarded as an approximation to a world where voting cycles are long. A key shortcoming of this approach is that, in general, as the distribution of agents changes, political preferences might also change. The level of b chosen at time zero may then no longer reflect the preferences of the living agents. By restricting the attention to SSPE, however, we avoid this possibility. In a SSPE where we let agents decide once-and-for-all, the outcome of the vote would not change if the ballot were to be (unexpectedly) repeated some time in the future. The institutions inherited from the past will therefore always reflect the preferences of the current generation.

It is also important to note that our notion of equilibrium is consistent with perfectly rational political behavior. When agents vote over a policy, they take into consideration the effects of alternative policy choices on transitional dynamics and tax rates. The assumption that there will be no vote in the future only means that agents do not have to be concerned with the effects of their vote today on future political decisions.[12]

We shall identify two candidate steady-state equilibria. One is characterized by a majority of unattached employed workers voting for a benefit rate sufficiently low to generate nonselective behavior in equilibrium. In this candidate SSPE, referred to as an *American Equilibrium (SSPE),* $\mu_0 = \mu^s(1)$. The other steady-state instead features a majority of attached employed workers voting for a benefit rate sufficiently high to generate selective behavior in equilibrium. In this candidate SSPE, referred to as a *European Equilibrium (SSPE),* $\mu_0 = \mu^s(0)$.

4.1 The American Equilibrium.

In an American SSPE, the unattached employed workers decide over the unemployment insurance policy. This policy implies zero unemployment benefits, and high mobility. Formally, an American SSPE is sustained if and only if $\bar{b} \geq 0$ and

$$V_n(1,0,0) \geq \sup_{b \in (\bar{b},w]} V_n(0, \tau(b, \mu^s(1), 0), b), \tag{6}$$

i.e., the unattached workers find it optimal to vote for zero benefits starting from the distribution $\mu^s(1)$, which induces nonselective behavior.[13]

The American equilibrium can be characterized as follows.

Proposition 2

An American SSPE exists if and only if

$$w \geq \begin{cases} \underline{w}(z) & \text{if} \quad z \leq z_A \\ w_A(z) > \underline{w}(z) & \text{if} \quad z > z_A \end{cases}$$

[12] In other work (e.g. Hassler et al., 2001), we have emphasized the effect of current political choices on future political outcomes.

[13] In fact, any benefit level below $\bar{b}$ gives the agents the same utility. Formally, $V_n(1, \tau(0, \mu^s(1), 0), 0) = V_n(1, \tau(b, \mu^s(1)), b)$ for all $b < \bar{b}$. The reason is that while there is a positive unemployment insurance, nobody is ever unemployed in equilibrium and $\tau(b < \bar{b}, \mu^s(1)) = 0$. Without loss of generality, we assume that $b = 0$ is chosen in this case. This would also be the choice under the realistic assumption that setting up an unemployment insurance system entails some cost.

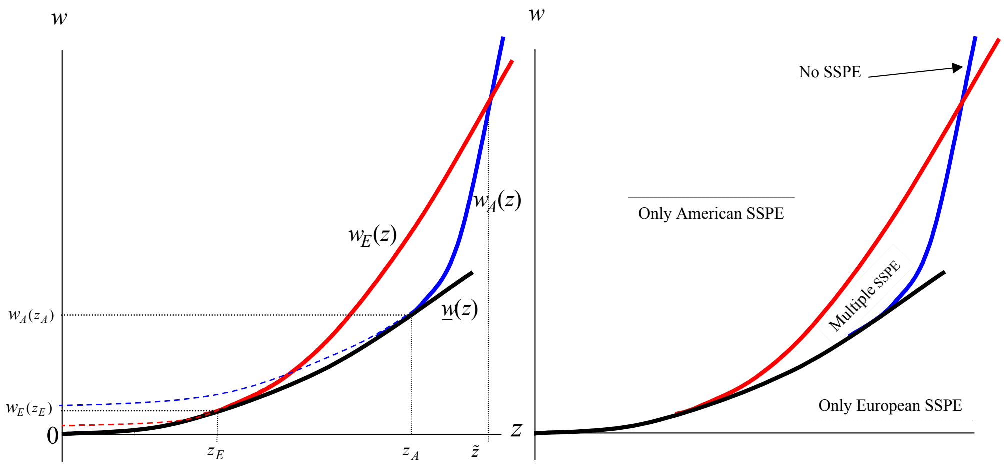

Figure 2: Multiple SSPE with no savings

where

$$z_A \equiv \frac{1}{\sigma} \ln \left(1 + \frac{T_A - P_{n,0}}{P_{n,1}(1 - T_A)}\right),$$

$$w_A(z) = \frac{1}{\sigma} \ln \left(\frac{(1 - P_{n,0})T_A}{P_{n,0}(1 - T_A)}\right) - \frac{1}{\sigma T_A} \ln \left(\frac{1 - P_{n,0}}{1 - T_A}\right) + \frac{1}{\sigma T_A} \ln \left(1 + P_{n,1}\left(e^{\sigma z} - 1\right)\right),$$

$$\underline{w}(z) = \frac{1}{\sigma} \ln \left(1 + \frac{P_{a,1}}{P_{a,0}}\left(e^{\sigma z} - 1\right)\right),$$

$$T_A \equiv T(\mu^s(1)) = \frac{(\gamma + \alpha + \rho)\,\alpha\gamma}{(\gamma + \alpha)(\pi + \gamma + \rho)(\alpha + \rho)}$$

with $w_A(0) > 0$, $w'_A(z) > 0$, $\underline{w}(0) = 0$, $\underline{w}'(z) > 0$, $w_A(z) \geq \underline{w}(z)$ *and* $w_A(z) = \underline{w}(z)$ *iff* $z = z_A$.

T_A can be interpreted as the *average discounted unemployment rate* when $\mu_0 = \mu^s(1)$ and workers search selectively. Moreover, $T_A > P_{n,0} = \frac{\alpha\gamma}{(\pi+\gamma+\rho)(\alpha+\rho)}$, implying that the unemployment insurance is less than actuarially fair for the unattached agents, since it transfers resources, in present discounted value terms, from the unattached to the attached.

Figure 2 (left hand panel) illustrates Proposition 2. The condition $w > \underline{w}(z)$ ensures that the threshold $\bar{b}$ is positive, so that non-selective behavior is optimal for a range of non-negative b. Thus, whenever $w < \underline{w}(z)$, non-selective search behavior cannot be induced and the American SSPE does not exist. The condition $w > w_A(z)$ implies, instead, that the expected utility of choosing a non-selective search strategy and setting benefits to zero is higher than that of choosing a selective search strategy and setting $b = \tilde{b}_{n,A}$, where

$$\tilde{b}_{n,A} \equiv \arg\max_b V_n(0, bT_A, b) = w - \frac{1}{\sigma} \ln \frac{(1 - P_{n,0})T_A}{P_{n,0}(1 - T_A)} \tag{7}$$

denotes the most preferred unemployment benefit for unattached workers, conditional on selective search behavior. Thus, $w > w_A(z)$ is sufficient for the existence of an American SSPE. In fact, this condition is also necessary as long as $\tilde{b}_{n,A} > \bar{b}$. This is always the case when $z > z_A$. When $z < z_A$, however, $\tilde{b}_{n,A} < \bar{b}$ and the unattached median voter always prefer $b = 0$ over any $b \geq \bar{b}$. In this case the American SSPE is also sustained in the range $w \in [\underline{w}(z), w_A(z)]$.

Figure 3 represents the value functions of the decisive unattached workers in two cases where an American equilibrium exists. In both cases, the value functions feature a downward discontinuity at $\bar{b}$ since, there, taxes increase from zero to $\bar{b}T_A$. The left hand panel represents a case where $z < z_A$. Whenever $z < z_A$, the value function of the unattached workers is non-increasing and strictly downward sloping for $b \geq \bar{b}$. Thus, the unattached median voter chooses no UI and the American SSPE is sustained as long as $w > \underline{w}(z)$, i.e., the non-selective search behavior is optimal absent UI (the picture represents a case where $w \in (\underline{w}(z), w_A(z))$). The right hand panel represents a case where $z > z_A$. In this case, the value function of the unattached workers is non-monotonic. After the discrete fall at $\bar{b}$, it first increases and then decreases with a local maximum at $\tilde{b}_{n,A}$. The American equilibrium exists as long as $w > w_A(z)$, which ensuring that $\tilde{V}_n$ has its global maximum at $b = 0$, as in the figure.

In summary, an American SSPE is sustained when w is sufficiently large and z is sufficiently low. Intuitively, w is the social opportunity cost of unemployment, while z is a measure of the cost of nonselective behavior. The lowest wage consistent with an American equilibrium (either $\underline{w}(z)$ or $w_A(z)$, depending on z) is increasing in z, as larger mobility costs require higher wages in order for the American SSPE to survive. As $z \to \infty$, $w_A(z)$ approaches its asymptote $\frac{z}{T_A}$ and the critical condition for the American SSPE to be sustained can be written as $w - z > w - wT_A$. Noting that T_A equals the average discounted unemployment rate, $w - wT_A$ is the income under selective behavior and full insurance we find that American equilibrium is sustained if and only if unemployment insurance provides agents with an average income that is lower than $w - z$, i.e., the worst realization in the case of no insurance.[14]

[14] Formally, when $z > z_A$, (6) can be rewritten

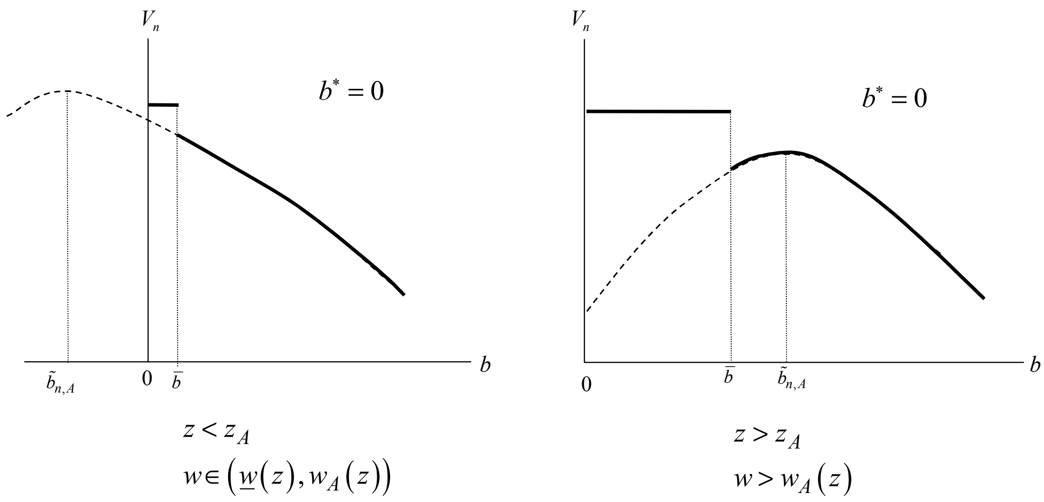

Figure 3: American SSPE

Finally, risk aversion affects the position of the threshold, z_A, and the shape of the curves $w_A(z)$ and $\underline{w}(z)$, but not their ranking (i.e., $w_A(z) > \underline{w}(z)$, irrespective of σ). A lower σ increases the range of parameters such that $\tilde{b}_{n,A} \leq 0$.

4.2 The European Equilibrium.

In a European SSPE, the attached employed workers are in majority and implement their most preferred UI policy. Given this policy, attached workers prefer to be unemployed than not move to get jobs. The European equilibrium exists if either $\bar{b} < 0$ (selective behavior is optimal even at zero UI) or $\bar{b} \geq 0$ and attached workers vote for a benefit level higher than

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$$(-1 - P_{n,1}(e^{\sigma z} - 1))\, e^{-\sigma w} > -e^{\sigma(w-d)T_A}\left(1 + P_{n,0}\left(e^{\sigma d} - 1\right)\right) e^{-\sigma w}$$

where $d \equiv w - \tilde{b}_{n,A} = \frac{1}{\sigma} \ln \frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}$. The LHS is the expected utility from non-selective behavior given no UI and the RHS is the expected utility from selective behavior given $b = \tilde{b}_{n,A}$. Letting z and w tend to infinity at a constant rate, yields the condition $w - z > w - wT_A$. The intuition is that under non-selective behavior, the expected utility becomes dominated by the income in the worst state (when paying the moving cost), since the size of the gamble $w - z$ becomes infinitely large. Under selective behavior, however, the size of the gamble is endogeneous and due to the CARA assumption constant and equal to d. As w goes to infinity the influence of d vanishes and expected utility becomes determined by average income ($w - wT_A$).

$\bar{b}$, inducing selective search behavior, or, more formally, when

$$V_a(1,0,0) < \sup_{b\in(\bar{b},w]} V_a(0,\tau(b,\mu^s(0),0),b). \tag{8}$$

The equilibrium unemployment insurance is given by;

$$\max\left\{\tilde{b}_{a,E},0\right\}, \tag{9}$$

where

$$\tilde{b}_{a,E} \equiv \arg\max_b V_a(0,\tau(b,\mu^s(0),0),b) = w - \frac{1}{\sigma}\ln\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}, \tag{10}$$

and $T_E \equiv T(\mu^s(0)) = \frac{\gamma}{\pi+\gamma} > T_A$ (hence, $\tau(b,\mu^s(0),0) = T_E b$). Due to assumption 1, $T_E > P_{a,0} = \frac{(1+\rho)\gamma}{\rho+\pi+\gamma}$, and the UI is less than actuarially fair for the attached in the European equilibrium, i.e., it entails a transfer, in present discounted value terms, from the employed to the unemployed. Thus, the employed workers never set full insurance in equilibrium, i.e., $\tilde{b}_{a,E} < w$.

The following proposition states necessary and sufficient conditions for the existence of a European equilibrium.

Proposition 3

The European SSPE exists if and only if

$$w < \begin{cases} \underline{w}(z) & \text{if} \quad z \le z_E \\ w_E(z) > \underline{w}(z) & \text{if} \quad z > z_E \end{cases}$$

where $\underline{w}(z)$ is as defined in Proposition 2 and

$$z_E \equiv \frac{1}{\sigma}\ln\left(1+\frac{T_E-P_{a,0}}{P_{a,1}(1-T_E)}\right),$$

$$w_E(z) = \frac{1}{\sigma}\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right) - \frac{1}{\sigma T_E}\ln\left(\frac{1-P_{a,0}}{1-T_E}\right) + \frac{1}{\sigma T_E}\ln\left(1+P_{a,1}\left(e^{\sigma z}-1\right)\right)$$

with $w_E(0) > 0$, $w_E'(z) > 0$, $w_E(z) \ge \underline{w}(z)$ and $w_E(z) = \underline{w}(z)$ iff $z = z_E$.

Consider again Figure 2 (left hand panel). A European SSPE exists whenever $w < \underline{w}(z)$, as in this region selective search behavior prevails irrespective of benefits. In the region where $w < w_E(z)$, the expected utility for the attached median voter is higher if she sets $b = \tilde{b}_{a,E}$ and chooses a selective search strategy than if she sets $b = 0$ and chooses a non-selective search strategy. Thus, $w < w_E(z)$ is a necessary condition for the existence

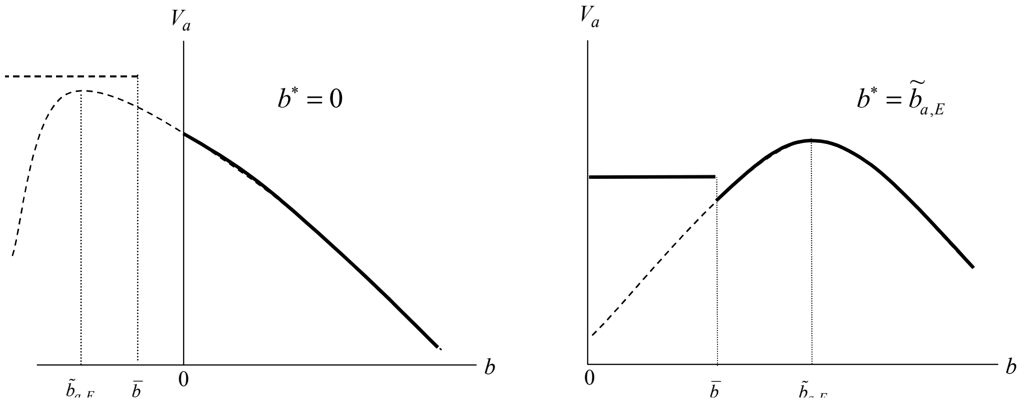

Figure 4: European equilibria

of a European SSPE. This condition is also sufficient as long as $\tilde{b}_{a,E} > \bar{b}$, which is always the case when $z > z_E$. When $z < z_E$, however, $\tilde{b}_{a,E} < \bar{b}$ and a European equilibrium can only exist if, for any benefit level, including $b = 0$, agents choose the selective behavior, i.e. if $w < \underline{w}(z)$.[15]

Figure 4 represents the value functions of the decisive attached workers in two cases where a European equilibrium exists. The left hand panel represents a case where $z < z_E$. The value function of the decisive voter is in this case downward sloping and there is no UI in equilibrium. Attached agents, however, do not move and there is unemployment. Thus, a European SSPE is sustained. The right hand panel represents a more interesting case where $z > z_E$ and $w > w_E(z)$, and there is positive UI in equilibrium. The value function of the unattached workers is non-monotonic. After the discrete fall at $\bar{b}$, it first increases and then decreases with a local maximum at $\tilde{b}_{a,E}$. This is in fact a global maximum (as guaranteed by the condition that $w > w_E(z)$) and this guarantees the existence of a European SSPE.

In summary, a European equilibrium tends to be sustained when w is sufficiently low and z is sufficiently large. The larger the mobility cost the larger the range of wages consistent with a European equilibrium. As $z \to \infty$, $w_E(z)$ approaches its asymptote $\frac{z}{T_E}$ implying that the critical condition for the European equilibrium to be sustained is that $w - wT_E \geq w - z$. Thus, when the moving cost becomes very large, the European equilibrium is sustained if and only if average income under selective behavior is at least as large as $w - z$. Finally, reducing σ increases the range of parameters such that $\tilde{b}_{a,E} = 0$.

[15] If $z < z_E$ and $w > \underline{w}(z)$, the value function of the attached workers is non-increasing and strictly downward sloping for $b \geq \bar{b} > 0$. Thus, the attached median voter chooses no UI and the European SSPE is not sustained.

4.3 Multiple SSPE

The results obtained so far can be summarized as follows. In economies with small mobility costs (z) and high wages (w), the majority of agents prefer to avoid the distortionary effects of unemployment insurance and are prepared to migrate to avoid unemployment. In these economies, an American SSPE tends to be sustained. In contrast, in economies with large mobility costs and low wages, the majority of agents prefer an unemployment insurance system in spite of its being less than actuarially fair for the employed workers. A European SSPE tends therefore to be sustained.

In this section, we prove that it is, in fact, possible that both an American and a European SSPE can be sustained in economies sharing the same structural parameters, and differing only in their initial distribution of labor market states. Hence, our model predicts that even if mobility costs were identical across countries, it would be possible to observe economies with very different rates of geographical mobility and unemployment insurances with stable majorities supporting the existing labor market institutions.

The main result of this section can be stated after introducing an additional assumption.[16]

Assumption 2 $\alpha < \bar{\alpha}$, *where*

$$\bar{\alpha} \equiv \frac{\pi^2 - D + \sqrt{\left(\pi^2 - D\right)^2 + 4\left(\pi + \rho\left(1-\gamma\right)\right)\left(\rho\pi^2 + \rho\left(\gamma^2 + \rho\right)\pi - \gamma D\right)}}{2\left(\pi + \rho\left(1-\gamma\right)\right)} > 0,$$

and $D \equiv \rho\left(1-\gamma\right)\left(\gamma+\rho\right)$.

Assumption 2 imposes a lower bound to the persistence of the state of non-attachment. The assumption is equivalent to imposing that the benefit level preferred by attached workers in a European steady-state exceed the level preferred by unattached workers in an American steady-state, i.e., $\tilde{b}_{a,E} > \tilde{b}_{n,A}$, where $\tilde{b}_{n,A}$ and $\tilde{b}_{a,E}$ are defined in (7) and (10), respectively. More formally,

$$\tilde{b}_{a,E} > \tilde{b}_{n,A} \Leftrightarrow \frac{1-P_{a,0}}{P_{a,0}}\frac{T_E}{1-T_E} \leq \frac{T_A}{1-T_A}\frac{1-P_{n,0}}{P_{n,0}}.$$

On the one hand, the ADP of being unemployed is higher for attached than for unattached workers ($P_{a,0} > P_{n,0}$), which tends to make the left-hand-side smaller than the right-hand-side. On the other hand, $T_E > T_A$, since the tax burden of financing UI is larger when

[16] The set of parameters satisfying both Assumption 1 and Assumption 2 is non-empty (see proof of Lemma 1 for details).

starting from a European steady-state with a positive stock of unemployment than from an American steady-state. This pulls the balance of the inequality in the opposite direction. The assumption that $\alpha < \bar{\alpha}$ implies that the difference between $P_{a,0}$ and $P_{n,0}$ is sufficiently large so that the former effect dominates, and $\tilde{b}_{a,E} > \tilde{b}_{n,A}$. As we will see, this is a necessary condition for existence of multiple SSPE. Additional restrictions on w and z will give the necessary and sufficient conditions.

Assumption 2 has the following implications.

Lemma 1 *Suppose that Assumption 2 holds. Then;*

1. *There exists a unique* $\tilde{z}$ *such that,* $\forall z \in (z_A, \infty)$, $z \gtreqless \tilde{z} \Leftrightarrow w_A(z) \gtreqless w_E(z)$, *and*
2. $\tilde{z} > z_A > z_E$.

Lemma 1 can be illustrated with the aid of Figure 2. Assumption 2 ensures that, as in the case represented in the Figure, (i) $z_A > z_E$ and (ii) the schedule $w_A(z)$ is steeper than the schedule $w_E(z)$, implying that there exists a compact region of the plane where both the American and the European SSPE are sustained. This region is characterized by the following key Proposition of the paper.

Proposition 4

Suppose that Assumption 2 holds. Then, an American and a European SSPE co-exist if and only if

1. $z \in [z_E, \tilde{z}]$ *and*
2. $$w \in \begin{cases} [\underline{w}(z), w_A(z)] & \text{if } z \in [z_E, z_A] \\ [w_E(z), w_A(z)] & \text{if } z \in [z_A, \tilde{z}] \end{cases}$$

where $\underline{w}(z), w_A(z), w_E(z), z_A, z_E, \tilde{z}, \bar{\alpha}$ *are defined in Propositions 2 and 3, Assumption 2 and Lemma 1.*

The proof follows immediately from Propositions 2 and 3 and from Lemma 1. The following Corollary, which follows immediately from Propositions 2 and 3 and from Lemma 1, can also be stated.

Corollary 1 *Suppose that Assumption 2 holds. Then, no SSPE exists if and only if* $z > \tilde{z}$ *and* $w \in [w_A(z), w_E(z)]$.

Proposition 4 and its corollary establish that if $z < \tilde{z}$, at least one SSPE exists. For a range of low z, $z \in [0, z_A]$, the SSPE is unique whereas, for a range of intermediate z, $z \in [z_A, \tilde{z}]$, multiple SSPE are possible. If $z > \tilde{z}$, finally, $w_A(z) > w_E(z)$ and there is a range of w where no SSPE exists, as stated by Corollary 1. The right hand panel of Figure 2 illustrates these findings by distinguishing the areas of uniqueness, multiplicity and non-existence of SSPE.

The intuition behind these results is the following. Two forces play in opposite directions. On the one hand, when the median voter is unattached, she tends to be less keen on social insurance than attached workers. The reason is that agents discount the future, and the prospect of unemployment is further away in time for unattached than for attached workers. Thus, the American median voter tends to oppose an insurance system, while the European median voter tends to support it and this "median voter effect" tends to generate multiple steady-states. On the other hand, since $T_E > T_A$, the cost of setting up social insurance in an American steady-state is lower than the cost of keeping it in place in a European steady-state. The reason is that in the American equilibrium, there are no unemployed to start with. This "tax effect" tends to generate non-existence rather than multiplicity of steady-states. If the preferences of the median voter were not sufficiently different, it is possible that the American voters would introduce an insurance system, while the European voters dismantle it. By imposing that non-attachment is sufficiently persistent, assumption 2 ensures that there is enough diversity in preferences between attached and unattached workers so that multiple SSPE can arise.

As we have noted above, at very high moving costs, the existence of the European (American) SSPE depends on whether average income under selective behavior is larger (smaller) income net of moving cost. However, since $T_E > T_A$, there will exist combinations of very high z and w, such that UI is capable of doing this when taxes are given by bT_A but incapable when taxes are given by bT_E. Then neither of the SSPE exists, i.e., if the initial unemployment rate is zero, the unattached voters prefer benefits above the threshold and when the initial unemployment is $\frac{\gamma}{\pi+\gamma}$, the attached voters prefer benefits below the threshold. Without savings, the region of non-existence exists for all parameters. As we will see in the next section, this is no longer true when we allow individuals to have access to a capital market.

To conclude, we note that risk aversion affects the range of wages and mobility costs that are consistent with multiple SSPE. In particular, lowering σ shifts the region of parameters featuring multiplicity in figure 2 to the North-East. Furthermore, for sufficiently low σ and given w, $\tilde{b}_{a,E} < 0$ and $\tilde{b}_{n,A} < 0$ in which case multiple SSPE cannot exists. In the limit case where $\sigma \to 0$ (risk neutrality) the region of multiplicity disappears. Risk aversion is therefore crucial for our results.

5 Allowing private capital accumulation

In this section, we enrich the model by adding two assumptions; finite lives and access to capital markets. As we will see, these extensions have no impact on the qualitative results of the model, but allow a more realistic calibration.[17]

Finite lives are introduced by assuming that individuals face a constant probability $\delta \in [0,1]$ of dying in each period.[18] The population is assumed to be constant over time; in every period, a measure δ of newborn agents replace those who die. Agents are born with zero assets, and are assumed to be unattached. The latter assumption is motivated by the empirical observation that moving rates fall with age. It implies, realistically, that a European SSPE will feature a positive rate of geographical mobility. We also assume that individuals have access to a perfect capital market, including a perfect annuity market (as in Blanchard, 1985), without borrowing constraints. The only imperfection maintained is that employment risk cannot be insured, other than through buffer stock savings.

Agents maximize (1), subject to sequence of dynamic budget constraints,

$$a_{t+1} = (1+\rho)\left(a_t + i_t - \zeta_t z - \tau - c_t\right), \tag{11}$$

a denoting financial assets and $i_t \in \{w, b\}$ earnings, and to a standard no-Ponzi game condition. We assume a constant risk-free interest rate, denoted by $r = (1+\rho)(1-\delta) - 1$, which is equal to the subjective discount rate conditional on survival (ρ being the unconditional subjective discount rate, coherent with equation (1)). Under this assumption, if labor income, i_t, were deterministic, agents would choose a flat consumption path with no savings.

Our choice of CARA utility has the important advantage that neither search nor mobility decisions depend on asset holding (as in Acemoglu and Shimer, 1999), nor do preferences over UI. More general preferences would imply that the distribution of individual wealth enters as a state variable, which would severely complicate the analysis (see Gomes, Greenwood and Rebelo (1998) for an example of a search model with self-insurance). The impact of individual wealth on job search and mobility is, empirically, ambiguous and remains an open issue in the literature.

[17] A more formal discussion, containing proofs of the claims in this section, can be found in the appendix.

[18] In order to ensure a majority of attached (unattached) in steady state when individual behavior is selective (nonselective), we assume $0 < \alpha \leq \gamma + \eta$ and $0 < \gamma < (\alpha - \eta)\,\frac{\pi+\eta}{\alpha+\eta}$.

For an infinite sequence of constant tax rates τ and benefit rates b, the *state* of an agent consists of her asset holdings, a_t, and her labor market status $\omega \in \Omega$. Due to the CARA utility specification, the value function is separable in asset holdings and labor market status. More specifically, the expected utility of an agent with asset holdings $a_t \in \mathbf{R}$ and labor market status $\omega \in \Omega$ who chooses search behavior ν, can be written as

$$V_\omega(\nu, a_t, \tau, b, z) = -\frac{1+\rho}{\rho} e^{-\sigma \frac{\rho}{1+\rho} a_t} e^{-\sigma c_\omega(\nu)}, \tag{12}$$

where $c_\omega(\nu)$ are constants solving the individual first-order conditions for optimally choosing consumption (proof in appendix).

Individual consumption equals capital income, $\frac{\rho}{1+\rho} a_t + c_\omega(\nu)$, where

$$\begin{aligned} c_\omega(0) &= w - \tau - s_{\omega,0}(w-b), \\ c_\omega(1) &= w - \tau - s_{\omega,1}(z). \end{aligned} \tag{13}$$

Saving under selective behavior ($s_{\omega,0}(w-b)$) is independent of assets, and is a strictly increasing function of the difference between income loss during unemployment, $w-b$. Similarly, saving under nonselective behavior ($s_{\omega,1}(z)$), is a strictly increasing function of the mobility cost, z. Without search frictions or under full insurance, agents would not engage in any savings, i.e., $s_{\omega,0}(0) = s_{\omega,1}(0) = 0$.

The attached employed workers choose selective behavior if and only if it implies lower saving than nonselective behavior, i.e., iff $s_{a,0}(w-b) \leq s_{a,1}(z)$. It is straightforward to show that $s_{a,0}(w-b) \leq s_{a,1}(z) \Leftrightarrow s_{n,0}(w-b) \leq s_{n,1}(z)$. Since $s'_{n,0}(w-b) > 0$, it is possible to define the inverse function $s_{n,0}^{-1}(s_{n,1}(z))$ and conveniently rewrite the condition for selective (non-selective) behavior to be optimal as

$$b > (\leq)\, w - s_{n,0}^{-1}(s_{n,1}(z)) \equiv \bar{b}. \tag{14}$$

This is the generalization of Proposition 1 to economies where agents can self-insure through borrowing and savings.

When choosing the benefit level, the median voter takes into account the effect of her choice on search behavior and taxes. Taxes are given by $\tau(b, \mu^s(0), 0) = bT_E$ and $\tau(b, \mu^s(1), 0) = bT_A$, where, as before, $T_E \geq T_A$ and $T_E = T_A$ if and only if $r = 0$.[19]

[19] Taking mortality risk into account, the expressions for T_E and T_A are, respectively;

$$T_E = \frac{\alpha}{\alpha + \frac{\delta}{1-\delta}} \frac{\gamma}{\frac{\delta}{1-\delta} + \pi + \gamma},$$

$$T_A = T_E \left(1 - \frac{r}{r + \delta + (\pi+\gamma)(1-\delta)}\right)\left(1 - \frac{1}{(\delta + (\alpha+\gamma)(1-\delta))} \frac{\gamma(1-\delta) r}{(r + \delta + \alpha(1-\delta))}\right).$$

We now study the conditions for existence and multiplicity of the European and American SSPE. We start by noting that, like in the no-saving case, the European SSPE exists and is unique if $\bar{b} < 0$, since, in this case, selective behavior is optimal for any feasible b. The condition $\bar{b} = 0$ in (14) defines a threshold wage $\underline{w}(s_{n,1}(z)) \equiv s_{n,0}^{-1}(s_{n,1}(z))$ such that a unique European SSPE exists for all $w < \underline{w}(s_{n,1}(z))$. Since the function $s_{n,0}(.)$ is increasing and convex (proof in the appendix), the inverse function, $\underline{w}(s_{n,1}(z))$, is concave and increasing in $s_{n,1}(z)$ (see figure 5).

A European SSPE also exists if $\bar{b} > 0$, and the utility of the European attached decisive voter is maximized by setting benefits above $\bar{b}$. Formally, this occurs whenever,

$$T_E \max\left\{\tilde{b}_{a,E}, \bar{b}\right\} < s_{a,1}(z) - s_{a,0}\left(w - \max\left\{\tilde{b}_{a,E}, \bar{b}\right\}\right), \tag{15}$$

where, consistently with the notation used in the previous section,[20]

$$\tilde{b}_{a,E} \equiv \arg\max_{b \leq w} \left\{w - bT_E - s_{a,0}(w-b)\right\}.$$

We can interpret the RHS of (15) as the insurance value that the attached median voter attributes to her most preferred UI, $\tilde{b}_{a,E}$, when she has the alternative option of moving to escape unemployment. The LHS is the tax cost of implementing $\tilde{b}_{a,E}$. Note that, if $\tilde{b}_{a,E}$ is interior, the following first-order condition holds;

$$-\frac{\partial}{\partial b} s_{a,0}(w-b)\,|_{b=\tilde{b}_{a,E}} = T_E. \tag{16}$$

Equation (16) implies that $\tilde{b}_{a,E}$ increases one-for-one in w. The same is true if the constraint $b \leq w$ binds. Therefore, the value of insurance (the RHS of (15)) is independent of w while, for the same reason, the cost of insurance (the LHS of (15)) increases linearly in w. Hence, there exists a unique threshold wage that equates the LHS to the RHS of (15). We denote this threshold by $w_E(s_{a,1}(z))$, and note that, for all $w < w_E(s_{a,1}(z))$, (15) is satisfied and a European SSPE exists. The threshold w_E is linearly increasing (with slope T_E^{-1}) in $s_{a,1}(z)$. For future comparisons, however, it is useful to express w_E as a function of $s_{n,1}(z)$, instead of $s_{a,1}(z)$. In the appendix, we show that $s_{n,1}(z)$ is an increasing convex transformation of $s_{a,1}(z)$. This justifies expressing w_E as a concave function of $s_{n,1}(z)$, $w_E = w_E(s_{n,1}(z))$(see figure 5).

[20] Note that, when δ is sufficiently high and α sufficiently low, the UI system is more than actuarially fair for the attached employed worker, in which case the condition $b \leq w$ binds. In this case, the European SSPE trivially exists, since selective behavior is optimal under full insurance.

As noted above, an American SSPE can only exist if $w \geq \underline{w}(s_{n,1}(z))$, implying that $\bar{b} > 0$. In addition, the American unattached median voter prefers to set zero UI to any benefit level larger than $\bar{b}$. This occurs whenever

$$T_A \max\left\{\tilde{b}_{n,A}, \bar{b}\right\} \geq s_{n,1}(z) - s_{n,0}\left(w - \max\left\{\tilde{b}_{n,A}, \bar{b}\right\}\right), \tag{17}$$

where $\tilde{b}_{n,A} \equiv \arg\max_{b \leq w}\{w - bT_A - s_{n,0}(w-b)\}$. Both $\tilde{b}_{n,A}$ and $\bar{b}$, as discussed above, increase one-for-one in w, and, hence, the RHS of (17) is independent of w, whereas the LHS increases linearly with w. Thus, (17) defines a unique threshold wage, $w_A(s_{n,1}(z))$, such that, if $w \geq w_A$, (17) is satisfied and an American SSPE exists. The threshold w_A is linearly increasing in $s_{n,1}(z)$, with slope equal to T_A^{-1} (see figure 5).

Let us now turn to the possibility of multiple SSPE. As in the case of no savings, a necessary condition for multiple SSPE to arise is that, were all agents forced to adopt a selective search behavior, the European attached median voter would prefer higher benefits than her American unattached counterpart. More formally, we need that $\tilde{b}_{n,A}(s_{n,1}(z)) < \tilde{b}_{a,E}(s_{n,1}(z))$. Unfortunately, we cannot express this condition as a close-form parametric restriction like Assumption 2. We can however ensure that the set of parameters consistent with the condition is non-empty.

Inspecting (15) and (17), we find, similarly to the no-saving case, two opposite forces. The "median voter effect" shows up in the fact that $-\frac{\partial}{\partial b}s_{a,0}(w-b) > -\frac{\partial}{\partial b}s_{n,0}(w-b)$ (proof in the appendix), whereas the "tax effect" is given, as before, by $T_E \geq T_A$. If the former effect dominates the latter, then $\tilde{b}_{n,A} > \tilde{b}_{a,E}$. An example where this occur is when r approaches zero. In this case, $T_A - T_E \to 0$, i.e., the "tax effect" vanishes, whereas, due to the positive mortality rate, subjective discount rates remain strictly positive, preventing the "median voter effect" from also vanishing. While this example hinges on the OLG structure introduced in this section, it is possible to prove, by means of examples, that multiple SSPE can also arise when $\delta = 0$ (see section 5.1 for an example).

Figure 5 illustrates the results of this section. We plot the three threshold schedules $\underline{w}(s_{n,1}(z))$, $w_E(s_{n,1}(z))$ and $w_A(s_{n,1}(z))$ as functions of the savings of the unattached workers, conditional on nonselective behavior. Similarly to figure 2, there are two critical values, $s_{n,1}(z_A)$ and $s_{n,1}(z_E)$, such that curves w_A and $\underline{w}$ and curves w_E and $\underline{w}$, respectively, are tangent. Since $s_{n,1}(z)$ is an increasing function of z, higher precautionary saving maps one-to-one into larger mobility costs. The American SSPE is sustained for combinations of w and $s_{n,1}(z)$ lying above the upper envelope of $\underline{w}(s_{n,1}(z))$ and $w_A(s_{n,1}(z))$, whereas the European SSPE is sustained for combinations of w and $s_{n,1}(z)$ lying below the upper envelope of $\underline{w}(s_{n,1}(z))$ and $w_E(s_{n,1}(z))$. As the figure shows, $s_{n,1}(z_A) > s_{n,1}(z_E)$, or

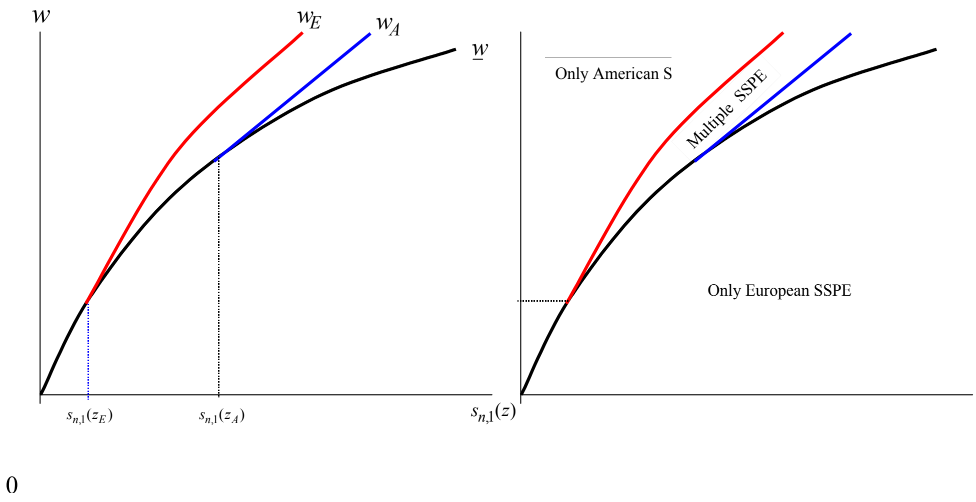

Figure 5: Multiple SSPE with saving

equivalently, $\tilde{b}_{n,A} < \tilde{b}_{a,E}$, implies the existence of a range of multiple SSPE.[21]

5.1 Calibration

In this section, we investigate whether the parameter range where multiplicity arises is economically reasonable. For this purpose, we calibrate the model. We assume that a period is one quarter and set the average duration of a working life to forty years with a constant population size. In addition, we assume the interest rate, r, to be 4% per year and calibrate the three remaining parameters of the transition matrix, α, γ, and π as follows.

1. As noted in the introduction, the rate of geographical mobility in the U.S. is approximately three times as large as in Western European countries. In our model, the migration rate in an American and a European SSPE are γ and $\gamma \cdot n_E$, respectively, where $n_E = \delta / (\delta + \alpha (1 - \delta))$ denotes the European steady-state share of employed

[21] In the appendix, we show that the curve w_E is asymptotically linear with slope $(1 + \rho) / T_E$. When mobility costs become very high, the condition for the existence of the European (American) SSPE is thus that $\frac{wT_e}{1+\rho}$ (wT_A) is smaller (larger) than the saving of the unattached under nonselective behavior. This condition is analogous with the case of no savings, except for the fact that the moving cost z is replaced by the saving induced by the moving cost. Thus, if and only if $(1 + \rho) / T_E < 1/T_A$, the schedules $w_E(s_{n,1}(z))$ and $w_A(s_{n,1}(z))$ eventually cross, and there is a region of parameters such that no SSPE exists. However, this condition need not hold. If, for example, r is sufficiently small, then $(1 + \rho) / T_E > 1/T_A$ and, in contrast to the case of no saving, at least one SSPE exists for any parameter configuration.

non-attached workers. Thus, given δ, we set α such that $n_E = 1/3$. This implies an average duration of non-attachment of almost twenty years ($\alpha = 0.0126$).[22] [23]

2. The parameter π is the inverse of the duration of unemployment. As our model abstracts from *frictional unemployment*, our notion of unemployment is *long-term unemployment*. To identify π, we assume that all frictional unemployed are rehired within one quarter. Using data from table 1 in Machin and Manning (1999), the weighted average share of unemployed in Europe who have been unemployed for more than 6 and 12 months can be computed to be 66.4% and 48.1%, respectively. The corresponding figures for the U.S. are 17.3% and 9.7%, confirming that long-term unemployment is negligible in the U.S.. In the model, the hazard rate from unemployment is constant and the probability of an unemployed not finding a job within two periods is $(1-\pi)^2$. Thus, π is estimated by setting $(1-\pi)^2 = 0.481/0.664$, yielding $\pi = 0.149$. This implies an expected unemployment duration of about 20 months, which is longer than the average unemployment duration in European countries (the weighted average from Eurostat data is 13 months, see Table 5 in Machin and Manning (1999)). Our definition of unemployment, however, does not include frictional unemployment, and the relevant figure is the average duration for long-term unemployed. Thus, we regard 20 months as a reasonable figure.

3. We calibrate γ, given our previous estimates of α and π, so as to generate an unemployment rate in the European steady-state of 8.2%. This unemployment target is motivated as follows: the weighted average unemployment rate in Europe was 10.8% in 1995 (standardized unemployment rates from the OECD Economic Outlook), compared to 5.5% in the U.S.. Given our measure of π, and given the data

[22] An alternative procedure to estimate α would be to use data on the cross-sectional age profile of moving rates. Since all newborn workers are assumed to be non-attached, our model predicts a declining age profile of mobility in the European SSPE. Formally, the average moving rate for a cohort of age t, $\gamma(t)$, in a European SSPE, is given by $\gamma(t) = (1-\alpha)\cdot\gamma(t-1)$. This relationship allows us to identify α using data on the rate at which the moving rate is falling with age in European countries. Pooling data from France, Germany and the United Kingdom (the large European countries for which we could find data on migration conditional on age) on workers aged between 25 and 45 (to minimize the effect of retirement), we estimate the expected duration of non-attachment to be 16.4 years. This figure is close to our benchmark estimate. If one calibrates the remaining parameters using this alternative estimate of α, the results of the model are practically undistinguishable from our benchmark calibration.

[23] One could, in principle, use absolute migration rates to pin down even γ. We decided against this option since migration rates depend on the geographical unit of account (state, county, etc.) whose choice would necessarily be arbitrary.

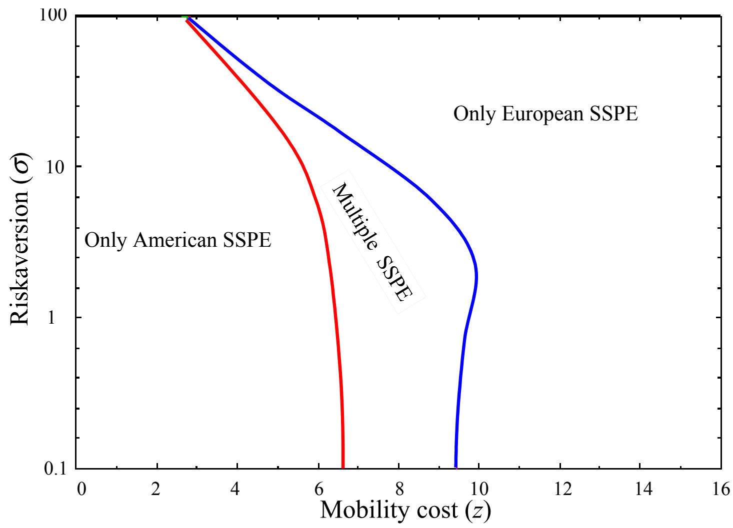

Figure 6: Multiple SSPE in the calibrated economy

on unemployment longer than 6 months, the implied frictional unemployment rates are 1.3% and 4.2% for Europe and the U.S., respectively.[24] The difference in long-term unemployment between Europe and the U.S. is then 8.2%, which implies setting $\gamma = 0.0218$.

Our calibration of α, π and γ implies that there is a majority of unattached workers in the U.S. (69%), and a majority of attached employed workers in the European steady-state (58.5%).

The remaining parameters of the model, σ and z, are not explicitly calibrated. Instead, we set $w = 1$ and show, in figure 6, ranges of values of σ and z that are consistent, respectively, with a unique American, a unique European and multiple SSPE. As the analysis has shown, a unique American (European) SSPE is sustained for small (large) mobility costs and low (high) risk aversion, and there exists a range of z and σ where multiple SSPE exist. We regard $\sigma \in [1, 10]$ as a "realistic" range. Given our calibration, in the range where multiple SSPE are sustained, the consumption of agents holding an average wealth level

[24]The model implies that a fraction π of the structurally unemployed exit unemployment even during the first two quarters. With $0.664 \cdot 10.8\%$ of the European work force being unemployed for more than two quarters, the number of workers entering into structural unemployment in each period can be computed as $y = \pi/(1-\pi)^2 \cdot 0.664 \cdot 10.8\%$. The implied frictional unemployment in Europe is then simply $10.8\% - y/\pi = 1.3\%$. A similar calculation using American data yields 4.2% for the U.S..

is around one, implying that the relative risk aversion is of the same order of magnitude as the absolute risk aversion. For $\sigma = 1$, multiple SSPE arise when the mobility costs is equivalent to 19.5-29 months of pre-tax wage, whereas for $\sigma = 10$ the corresponding range is 16.5-23 months. These ranges are not particularly unrealistic, once both pecuniary and non-pecuniary costs are accounted for. For instance, using micro data, Kennan and Walker (2001) estimate the mobility costs to be of the order of several years of labor earnings.

In our calibrated economies, the attached median voter receives a positive transfer in present discounted value terms from the UI system. Thus, she values UI from both an insurance and a transfer motive. As a result, the European SSPE has the stark property that attached workers vote for full unemployment insurance. The feature of our model driving this result is the fact that, above the threshold $\bar{b}$, taxes are linear in the benefit level because, except for the discrete change in mobility behavior at $\bar{b}$, there are no additional distortionary effects of taxation. A richer model might include other distortions implying an increasing marginal cost of taxation and benefit provision. In this case, it may no longer be optimal for attached workers to set full insurance. To illustrate this point in a reduced-form fashion assume, for instance, that $\tau = T_E(b + b^2/2)$ rather than $\tau = T_E b$. Furthermore, set $\sigma = 5$ and $z = 9$. Then, both SSPE exist and the benefit rate in the European equilibrium is 72%. In this SSPE, the average cost of taxation equals 1.36 dollars per dollar of benefit paid.

We have repeated the experiment for economies having the same parameters as in the benchmark calibration, but with infinitely lived agents ($\delta = 0$). In this case, the transfer effect is never in favor of the median voter, and the political equilibrium features no UI when agents are risk neutral, irrespective of z. Hence, there is no multiple SSPE for low σ's, whereas multiple SSPE emerge for larger risk aversion. Multiple steady states exist, for some interval of z, when $\sigma \in [1, 20]$, although the range of parameters for which multiple SSPE arise is smaller than in the previous case. For instance, if $\sigma = 5$, we have multiple equilibria for moving costs between 31 and 34 months of pre-tax wage.

To conclude, we emphasize that while our calibration shows that the possibility of multiple SSPE is not a theoretical "curiosum", but does arise for realistic parameters, it is likely that other factors create differences in moving costs across countries. Our theory shows that these differences need not be large in order for large differences in economic outcomes to arise.

6 Conclusion

This paper has moved from the observation of three cross-country empirical regularities: (i) unemployment is negatively correlated with geographical mobility, (ii) geographical mobility is negatively correlated with the generosity of the unemployment insurance (iii) unemployment insurance is positively correlated with unemployment. Rather than taking institutions and, in particular, unemployment insurance, as exogenous, we have taken the approach to derive them as the outcome of rational collective choice.

We regard the analysis as fruitful in a number of respects. First, it shows that endogenizing political decisions can enlighten non-trivial self-reinforcing mechanisms, thereby showing that large cross-country differences in economic performance need not arise from large discrepancies in preferences or technology that might be difficult to rationalize. Second, we regard the methodological contribution of the paper to be of independent interest. The paper provides a tractable framework that can be extended to the analysis of a variety of dynamic macroeconomic problems with endogenous policy determination. At the same time, the model is sufficiently rich to enable a quantitative assessment of the theory.

Analytical results are obtained by exploiting properties of the CARA utility functions (as in e.g. Acemoglu and Shimer (1999) and Hassler and Rodríguez Mora (1999)). In future work, we plan to examine to what extent the results are robust to an arguably more realistic modeling of risk aversion, such as CRRA functions. Our analysis has also been simplified by the assumption that agents vote once-and-for-all over a constant benefit-tax sequence. It is possible, however, to extend the analysis to allow for repeated voting, and show the existence of multiple SSPE in the class of Markov Perfect Equilibria (details available upon request). Although UI is typically lower than in the case of once-and-for-all voting, the main qualitative results of this paper are therefore robust to the introduction of repeated voting.

A general message of our paper is that existing social institutions affect preferences over these institutions. One conclusion from our results is that inertia in changing social institutions may emerge endogenously, even if no exogenous cost of change is involved. There is, for example, political support for a generous unemployment insurance in Europe, despite a growing consensus that this causes high unemployment. If the insurance system were dismantled, though, political support for restoring it might erode over time, which is a positive conclusion. Note, however, that our model implies that it might even be *socially* optimal for Europe and the U.S. to retain their respective status quo UI systems. Analyzing this and other related normative questions is left for future work.

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7 Appendix

7.1 Value functions

The value functions of each agent conditional on their type, their search strategy, ν and the initial distribution, μ_0 satisfies the recursive formulation,

$$\begin{aligned} V_a(\nu,\tau,b) &= -e^{-\sigma(w-\tau)} + \beta\left[(1-\gamma)V_a(\nu,\tau,b)\right. \\ &\quad +\gamma\nu\left(-e^{-\sigma(w-\tau-z)} + e^{-\sigma(w-\tau)} + V_n(\nu,\tau,b)\right) \\ &\quad \left.+\gamma(1-\nu)V_u(\nu,\tau,b)\right], \end{aligned} \tag{18}$$

$$V_n(\nu,\tau,b) = -e^{-\sigma(w-\tau)} + \beta\left[\alpha V_a(\nu,\tau,b) + (1-\alpha)V_n(\nu,\tau,b)\right], \tag{19}$$

$$\begin{aligned} V_u(\nu,\tau,b) &= -e^{-\sigma(b-\tau)} + \beta\left[\pi V_a(\nu,\tau,b) +\right. \\ &\quad +(1-\pi)\nu\left(-e^{-\sigma(w-\tau-z)} + e^{-\sigma(w-\tau)} + V_n(\nu,\tau,b)\right) \\ &\quad \left.+(1-\pi)(1-\nu)V_u(\nu,\tau,b)\right], \end{aligned} \tag{20}$$

where $\tau = \tau(b,\mu_0,\nu)$.

Solving the system of equations (18)-(19)-(20) yields (5), where

$$\begin{aligned} P_{a,0} &= \frac{(1+\rho)\gamma}{\rho+\pi+\gamma}, \\ P_{n,0} &\equiv \frac{(1+\rho)\gamma\alpha}{(\rho+\pi+\gamma)(\rho+\alpha)}, \\ P_{u,0} &= \frac{\rho(1-\pi)+\gamma}{\rho+\pi+\gamma}, \\ P_{a,1} &= \frac{(\rho+\alpha)\gamma}{\rho+\alpha+\gamma}, \\ P_{n,1} &= \frac{\gamma\alpha}{\rho+\alpha+\gamma}, \\ P_{u,1} &= \frac{(\rho+\alpha)}{(1+\rho)}\frac{(\rho(1-\pi)+\gamma)}{(\rho+\alpha+\gamma)} \end{aligned}$$

From the expressions for the ADP's it follows that $P_{a,1}/P_{a,0} = P_{n,1}/P_{n,0} = P_{u,1}/P_{u,0}$, $V_a(0,\tau,b) \geq (\leq)\ V_n(1,\tau,b) \Leftrightarrow V_n(0,\tau,b) \geq (\leq)\ V_a(1,\tau,b) \Leftrightarrow V_u(0,\tau,b) \geq (\leq)\ V_u(1,\tau,b)$.

7.2 Proof of proposition 1

1 The threshold is found by solving $P_{a,0}\left(e^{-\sigma\bar{b}} - e^{-\sigma w}\right) = P_{a,1}\left(e^{-\sigma(w-z)} - e^{-\sigma w}\right)$.

7.3 Proof of proposition 2

First, the condition that $w \geq \underline{w}(z)$ ensures that $\bar{b} \geq 0$, and that $\nu = 1$ is an ESB for some feasible levels of b including $b = 0$ (see Proposition 1).

Second, we need to show that $V_n(1,0,0) \geq \sup_{b\in(\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b)$. We start by observing that the function $V_n(0,\tau(b,\mu_0,0),b)$ is concave in b. This follows immediately after noting that $\tau(b,\mu(1),0)$ is a linear function of b. More precisely, $\tau(b,\mu(1),0) = T_A b$. We prove, next, that $\bar{b} = \arg\max_{b\in[\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b)$ (thus, $\sup_{b\in(\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b) = V_n(0,T_A\bar{b},\bar{b})$) if and only if $z \leq z_A$, whereas $\bar{b} < \arg\max_{b\in[\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b)$ (thus, $\sup_{b\in(\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b) = V_n(0,T_A b,b)$ for some $b \in (\bar{b},w)$) if and only if $z > z_A$. To this aim, define $\tilde{b}_{n,A} \equiv \arg\max_{b\in[0,w]} V_n(0,\tau(b,\mu^s(1),0),b)$. Using the First Order Condition and the fact that $V_n(0,\tau(b,\mu^s(1),0),b)$ is concave in b, it can be shown by standard technique that $\tilde{b}_{n,A} = w - \frac{1}{\sigma}\ln\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}$. The concavity of $V_n(0,\tau(b,\mu^s(1),0),b)$ in b also ensures that $\bar{b} \geq \tilde{b}_{n,A} \Leftrightarrow \bar{b} = \arg\max_{b\in[\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b)$, whereas $\bar{b} < \tilde{b}_{n,A} \Leftrightarrow \bar{b} < \arg\max_{b\in[\bar{b},w]} V_n(0,\tau(b,\mu^s(1),0),b) = \tilde{b}_{n,A}$. Using the definitions of $\bar{b}$ and $\tilde{b}_{n,A}$, we obtain

$$\begin{aligned}
\bar{b} &\geq (<)\,\tilde{b}_{n,A} \\
&\Leftrightarrow w - \frac{1}{\sigma}\ln\left(1+\frac{P_{n,1}}{P_{n,0}}\left(e^{\sigma z}-1\right)\right) \geq (<)\, w - \frac{1}{\sigma}\ln\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}, \text{ hence,} \\
\bar{b} &\geq (<)\,\tilde{b}_{n,A} \Leftrightarrow z \leq (>)\,\frac{1}{\sigma}\ln\left(1+\frac{T_A-P_{n,0}}{P_{n,1}\left(1-T_A\right)}\right) \equiv z_A.
\end{aligned}$$

Consider, next, the two cases separately. We first study the case in which $z \leq z_A$ and $\sup_{b\in(b,w]} V_n(0,\tau(b,\mu^s(1),0),b) = V_n(0,T_A\bar{b},\bar{b})$. Since $V_n(1,0,0) = V_n(1,0,\bar{b}) = V_n(0,0,\bar{b}) > V_n(0,T_A\bar{b},\bar{b})$, the American equilibrium is always sustained in this case. Next, consider the case in which $z > z_A$ and $\sup_{b\in(b,w]} V_n(0,\tau(b,\mu^s(1),0),b) = V_n(0,T_A\tilde{b}_{n,A},\tilde{b}_{n,A})$. In this case, we need to prove that $V_n(1,0,0) \geq V_n(0,\tilde{b}_{n,A}T_A,\tilde{b}_{n,A})$. Using the definition of the $V_n(\nu,\tau,b)$ function, we operate as follows;

$$\begin{aligned}
& -e^{-\sigma w} - P_{n,1}\left(e^{-\sigma(w-z)} - e^{-\sigma w}\right) \\
&\geq -e^{\sigma\tilde{b}_{n,A}T_A}\left(e^{-\sigma w} + P_{n,0}\left(e^{-\sigma\left(w-\frac{1}{\sigma}\ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right)\right)} - e^{-\sigma w}\right)\right), \\
e^{-\sigma w}\left(1+P_{n,1}\left(e^{\sigma z}-1\right)\right) &\leq e^{\sigma\tilde{b}_{n,A}T_A}\left(e^{-\sigma w} + P_{a,0}\left(e^{-\sigma w+\ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right)} - e^{-\sigma w}\right)\right) \\
&= e^{-\sigma(1-T_A)w}\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right)^{-T_A}\frac{1-P_{n,0}}{1-T_A}.
\end{aligned}$$

Hence;

$$e^{-\sigma T_A w}\left(1+P_{n,1}\left(e^{\sigma z}-1\right)\right) \leq \left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right)^{-T_A}\frac{1-P_{n,0}}{1-T_A},$$

and, finally,

$$
\begin{aligned}
V_n(1,0,0) &\geq V_n(0,\tilde{b}_{n,A}T_A,\tilde{b}_{n,A}) \Leftrightarrow \\
w &\geq \frac{1}{\sigma}\ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right) - \frac{1}{\sigma T_A}\ln\left(\frac{1-P_{n,0}}{1-T_A}\right) + \frac{1}{\sigma T_A}\ln\left(1+P_{n,1}\left(e^{\sigma z}-1\right)\right) \equiv w_A(z).
\end{aligned}
$$

Finally, we need to prove that, $\forall z > z_A$, $w_A(z) > \underline{w}(z)$. This ensures that the threshold $\bar{b}$ is positive in the American equilibrium. We prove this fact as part of the following more general Lemma which will be useful again later in this paper.

Lemma 2 $\forall z \in R^+ \setminus z_A$, $w_A(z) \geq \underline{w}(z)$. *Furthermore,* $w_A(z_A) = \underline{w}(z_A)$.

Let $W_A(z) \equiv w_A(z) - \underline{w}(z)$. Then

$$
\begin{aligned}
0 &= W_A(z_A) = \frac{1}{\sigma}\ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right) - \frac{1}{\sigma T_A}\ln\left(\frac{1-P_{n,0}}{1-T_A}\right) + \\
&\frac{1}{\sigma T_A}\ln\left(1+P_{n,1}\left(\frac{T_A-P_{n,0}}{P_{n,1}(1-T_A)}\right)\right) - \frac{1}{\sigma}\ln\left(1+\frac{P_{n,1}}{P_{n,0}}\left(\frac{T_A-P_{n,0}}{P_{n,1}(1-T_A)}\right)\right)
\end{aligned}
$$

Next, observe that

$$
\begin{aligned}
\frac{\partial W_A(z)}{\partial z} &= P_{n,1}e^{\sigma z}\left(\frac{P_{n,1}(1-T_A)(e^{\sigma z}-1)-(T_A-P_{n,0})}{T_A(1+P_{n,1}e^{\sigma z}-P_{n,1})(P_{n,0}+P_{n,1}(e^{\sigma z}-1))}\right), \text{ and} \qquad (21) \\
0 &= \frac{\partial W_A(z_A)}{\partial z} = P_{n,1}e^{\sigma z_A}\left(\frac{(T_A-P_{n,0})-(T_A-P_{n,0})}{T_A(1+P_{n,1}e^{\sigma z}-P_{n,1})\left(P_{n,0}+\left(\frac{T_A-P_{n,0}}{(1-T_A)}\right)\right)}\right).
\end{aligned}
$$

Furthermore, since the sign of $\frac{\partial W_A(z)}{\partial z}$ is determined by the numerator of the right hand side expression in (21), and the numerator is increasing in z, then, clearly $\frac{\partial W_A(z)}{\partial z} \gtrless 0 \Leftrightarrow z \gtrless z_A$. But, since $W_A(z_A) = 0$, then it follows that $W_A(z) \equiv w_A(z) - \underline{w}(z) > 0 \Leftrightarrow z \neq z_A$, and $w_A(z_A) = \underline{w}(z_A)$. This proves the Lemma. QED.

Finally, it is straightforward that $\underline{w}(0) = 0$, while $w_A(0) > 0$, is implied by

$$
\begin{aligned}
\ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\right) - \frac{1}{T_A}\ln\left(\frac{1-P_{n,0}}{1-T_A}\right) &= \ln\left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\left(\frac{1-T_A}{1-P_{n,0}}\right)^{1/T_A}\right) > 0 \\
&\Leftrightarrow \left(\frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)}\left(\frac{1-P_{n,0}}{1-T_A}\right)^{-1/T_A}\right) \\
&= \left(\frac{1-T_A}{1-P_{n,0}}\right)^{\frac{1-T_A}{T_A}}\frac{T_A}{P_{n,0}} > 1,
\end{aligned}
$$

where the final inequality follows from noting that $\left(\frac{1-T}{1-P}\right)^{\frac{1-T}{T}}\frac{T}{P} = 1$ if$P = T$, $\frac{\partial}{\partial P}\left(\frac{1-T}{1-P}\right)^{\frac{1-T}{T}}\frac{T}{P} = (1-T)^{\frac{1-T}{T}}(1-P)^{-\frac{1}{T}}\frac{T-P}{P^2}$ and $T_A > P_{n,0}$.

7.4 Proof of proposition 3.

Proof: That a European Equilibrium is sustained when $w < \underline{w}(z)$, implying that $\bar{b} < 0$ is an immediate implication of the fact that, in this case, $\nu = 0$ is an ESB irrespective of b (see Proposition 1).

The rest of the proof deals with the case in which $\bar{b} > 0$.We start by observing that the function $V_a(0, \tau(b, \mu_0, 0), b)$ is concave in b. This follows immediately after noting that $\tau(b, \mu(0), 0)$ is a linear function of b. More precisely, $\tau(b, \mu(0), 0) = T_E b$. We now prove by contradiction that the condition $\tilde{b}_{a,E} > \bar{b}$ is necessary for an European Equilibrium to exist. Suppose that there exists a European Equilibrium such that $\tilde{b}_{a,E} \leq \bar{b}$. Then, the concavity of $V_a(0, \tau(b, \mu_0, 0), b)$ implies that $V_a(.)$ is decreasing in b for all $b > \bar{b}$. Furthermore, $V_a(1, 0, 0) > V_a(1, \tau(\bar{b}, \mu(0), 1), \bar{b}) = V_a(0, \tau(\bar{b}, \mu(0), 1), \bar{b}) < V_a(0, T_E\bar{b}, \bar{b}) \leq V_a(0, T_E\tilde{b}_{a,E}, \tilde{b}_{a,E})$, which contradicts the statement that we are in a European equilibrium.

Next, we prove that $z > z_E \Leftrightarrow \tilde{b}_{a,E} > \bar{b}$. Using the definitions of $\tilde{b}_{a,E}$ and $\bar{b}$ (see (9) and Proposition 1)

$$\tilde{b}_{a,E} > \bar{b} \Leftrightarrow w - \frac{1}{\sigma}\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right) \geq w - \frac{1}{\sigma}\ln\left(1 + \frac{P_{a,1}}{P_{a,0}}\left(e^{\sigma z} - 1\right)\right),$$

hence, after simplifying, $\tilde{b}_{a,E} > \bar{b} \Leftrightarrow z > \frac{1}{\sigma}\ln\left(1 + \frac{T_E - P_{a,0}}{P_{a,1}(1-T_E)}\right) \equiv z_E$.

Next, we prove that, conditional on $z > z_E$, $w < w_E(z)$ is necessary and sufficient for $V_a(1,0,0) < V_a(0, \tilde{b}_{a,E}T_E, \tilde{b}_{a,E})$. Using the definition of the $V_n(\nu, \tau, b)$ function, we operate as follows;

$$\begin{aligned}
& -e^{-\sigma w} - P_{a,1}\left(e^{-\sigma(w-z)} - e^{-\sigma w}\right) \\
< & -e^{\sigma \tilde{b}_{a,E}T_E}\left(e^{-\sigma w} + P_{a,0}\left(e^{-\sigma\left(w - \frac{1}{\sigma}\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right)\right)} - e^{-\sigma w}\right)\right) \\
e^{-\sigma w}\left(1 + P_{a,1}\left(e^{\sigma z} - 1\right)\right) > & \; e^{\sigma \tilde{b}_{a,E}T_E} e^{-\sigma w}\left(1 + P_{a,0}\left(e^{\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right)} - 1\right)\right) \\
= & \; e^{-\sigma(1-T_E)w}\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right)^{-T_E}\frac{1-P_{a,0}}{1-T_E}
\end{aligned}$$

Hence;

$$e^{-\sigma T_E w}\left(1 + P_{a,1}\left(e^{\sigma z} - 1\right)\right) \geq \left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right)^{-T_E}\frac{1-P_{a,0}}{1-T_E}$$

and, finally,

$$\begin{aligned}
V_a(1,0,0) & < V_a(0, \tilde{b}_{a,E}T_E, \tilde{b}_{a,E}) \Leftrightarrow \\
w & < \frac{1}{\sigma}\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right) - \frac{1}{\sigma T_E}\ln\left(\frac{1-P_{a,0}}{1-T_E}\right) + \frac{1}{\sigma T_E}\ln\left(1 + P_{a,1}\left(e^{\sigma z} - 1\right)\right) \equiv w_E(z).
\end{aligned}$$

Finally, we need to prove that, $\forall z > z_E$, $w_E(z) > \underline{w}$. This ensures that there exist European Equilibria such that the threshold $\bar{b}$ is positive. We prove this fact as part of the following Lemma which will be useful again later in this paper.

Lemma 3 $\forall z \in R^+ \setminus z_E$, $w_E(z) \geq \underline{w}(z)$. *Furthermore,* $w_E(z_E) = \underline{w}(z_E)$.

Let $W_E(z) \equiv w_E(z) - \underline{w}(z)$. Then

$$\begin{aligned} 0 &= W_E(z_E) = \frac{1}{\sigma}\ln\left(\frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}\right) - \frac{1}{\sigma T_E}\ln\left(\frac{1-P_{a,0}}{1-T_E}\right) + \\ &\quad \frac{1}{\sigma T_E}\ln\left(1+P_{a,1}\left(\frac{T_E-P_{a,0}}{P_{a,1}(1-T_E)}\right)\right) - \frac{1}{\sigma}\ln\left(1+\frac{P_{a,1}}{P_{a,0}}\left(\frac{T_E-P_{a,0}}{P_{a,1}(1-T_E)}\right)\right)\end{aligned}$$

Next, observe that

$$\frac{\partial W_E(z)}{\partial z} = P_{a,1}e^{\sigma z}\left(\frac{P_{a,1}(1-T_E)(e^{\sigma z}-1)-(T_E-P_{a,0})}{T_E(1+P_{a,1}e^{\sigma z}-P_{a,1})(P_{a,0}+P_{a,1}(e^{\sigma z}-1))}\right), \text{ and} \tag{22}$$

$$0 = \frac{\partial W_E(z_E)}{\partial z} = P_{a,1}e^{\sigma z_E}\left(\frac{(T_E-P_{a,0})-(T_E-P_{a,0})}{T_E(1+P_{a,1}e^{\sigma z}-P_{a,1})\left(P_{a,0}+\left(\frac{T_E-P_{a,0}}{(1-T_E)}\right)\right)}\right).$$

Furthermore, since the sign of $\frac{\partial W_E(z)}{\partial z}$ is determined by the numerator of the right hand side expression in (21), and the numerator is increasing in z, then, clearly $\frac{\partial W_E(z)}{\partial z} \gtreqless 0 \Leftrightarrow z \gtreqless z_E$. But, since $W_E(zE) = 0$, then it follows that $W_E(z) \equiv w_E(z) - \underline{w}(z) > 0 \Leftrightarrow z \neq z_E$, and $w_E(z_E) = \underline{w}(z_E)$. This proves the Lemma. QED.

7.5 Proofs of Lemma 1

Part 1. We know from Propositions 2 and 3 and from Lemma 2 (in the appendix) that both $w_A(z)$ and $w_E(z)$ are increasing in z and that $w_E(z_A) > w_A(z_A) = \underline{w}(z_A)$.

Next, define

$$\Delta_w(z) \equiv w_E(z) - w_A(z) = K + \ln\frac{(1+P_{a,1}(e^{\sigma z}-1))^{(1/T_E)}}{(1+P_{n,1}(e^{\sigma z}-1))^{(1/T_A)}}$$

where K is a constant term which does not depend on z. Since $1/T_E < 1/T_A$, then $\lim_{z\to\infty}\Delta_w(z) = 0$ implying, from continuity, that, for sufficiently large z, $w_E(z) < w_A(z)$. Thus, from the intermediate value theorem, there must exists $\tilde{z} > z_A$ such that $w_A(\tilde{z}) = w_E(\tilde{z})$.

Finally, we prove that $\tilde{z}$ is a unique. Take the first derivative;

$$\begin{aligned} \Delta'_w(z) &= \frac{1}{T_E}\frac{\sigma e^{\sigma z}}{(1+P_{a,1}(e^{\sigma z}-1))} - \frac{1}{T_E}\frac{\sigma e^{\sigma z}}{(1+P_{a,1}(e^{\sigma z}-1))}, \text{ implying} \\ \text{sign}\left\{\Delta'_w(z)\right\} &= \text{sign}\left\{\frac{T_A-T_E}{\left(T_E-\frac{P_{n,1}}{P_{a,1}}T_E\right)P_{a,1}} - e^{\sigma z}\right\}, \end{aligned} \tag{23}$$

where $\left(T_E - \frac{P_{n,1}}{P_{a,1}} T_E\right) = \frac{\alpha\gamma\rho(\pi-\alpha)}{(\gamma+\alpha)(\pi+\gamma+\rho)(\gamma+\pi)(\rho+\alpha)} > 0$. Next, recall that $w'_E(z_A) > w'_A(z_A) = \underline{w}(z_A)$, implying that $\Delta'_w(z_A) > 0$. Assume, now, in contradiction with the uniqueness of $\tilde{z}$, that there exist z_2 such that $z_2 > \tilde{z} > z_A$ and such that $\Delta_w(\tilde{z}) = \Delta_w(z_2) = 0$. Since $\Delta_w(z_A) > 0$ and $\Delta'_w(z_A) > 0$ there needs exist $\hat{z}$ such that $z_A < \hat{z} < \tilde{z}$ and $\Delta'_w(\hat{z}) = 0$. Additionally, from (23), $\tilde{z} > \hat{z}$ and $\Delta'_w(\hat{z}) = 0$ jointly imply that $\Delta'_w(\tilde{z}) < 0$ and $\Delta'_w(z) < 0$ for all $z \geq \tilde{z}$. But, then,there cannot exist $z_2 > \tilde{z}$ such that $\Delta_w(z_2) = 0$. A contradiction. This proves the uniqueness of $\tilde{z}$ and concludes the proof of the Lemma.

Part 2. From the definitions of z_A and z_E (see Propositions 2 and 3, respectively);

$$z_A > z_E \Leftrightarrow \frac{T_A - P_{n,0}}{P_{n,1}(1-T_A)} > \frac{T_E - P_{a,0}}{P_{a,1}(1-T_E)}.$$

Rearranging terms and using the fact that $P_{a,1}/P_{n,1} = P_{a,0}/P_{n,0}$, we obtain;

$$z_A > z_E \Leftrightarrow \frac{(1-P_{n,0})T_A}{P_{n,0}(1-T_A)} > \frac{(1-P_{a,0})T_E}{P_{a,0}(1-T_E)}$$

Substituting into the left hand side inequality the expressions of $P_{n,0}, P_{a,0}, T_A$ and T_E, and rearranging terms, we obtain

$$(\pi + \rho(1-\gamma))\alpha^2 - \left(\pi^2 - \rho(1-\gamma)(\gamma+\rho)\right)\alpha - \left(\rho\pi^2 + \left(\rho\gamma^2 + \rho^2\right)\pi - \rho(1-\gamma)\left(\gamma^2 + \gamma\rho\right)\right) < 0$$

Given Assumption 1, the above inequality is satisfied if and only if $\alpha \in [0, \bar{\alpha}]$, where $\bar{\alpha}$ is as defined in assumption 2. To conclude, we verify that the set of parameters satisfying both Assumptions 1 and 2 is not vacuous. Let $\rho \to 0$. Then, $\bar{\alpha} \to \pi$ and Assumption 2 imposes no additional restriction.

Finally, the proof of Part 1 of the Lemma established that $\tilde{z} > z_A$. QED

7.6 Proof of Claims in section 5

7.6.1 Bellman equations

Given a search strategy ν, it is immediate to show that the proposed value functions in (12) satisfy the Bellman equations,

$$\begin{aligned} V_\omega(\nu, a_t, \tau, b; z) &= \max_{c_t} -e^{-\sigma c_t} - \frac{1}{1+\rho} \sum_{\omega' \in \Omega} \Gamma_{\omega,\omega'}(\nu) V_{\omega'}(\nu, a_t, \tau, b; z) \\ \text{s.t. } a_{t+1} &= (1+\rho)(a_t + i_t - \zeta_t z - \tau - c_t), \end{aligned}$$

if

$$c_t = c_\omega(a_t, \nu) = \frac{\rho}{1+\rho} a_t + c_\omega(\nu),$$

where $c_\omega(\nu)$ satisfies

$$1 = \sum_{\omega\prime\in\Omega} \Gamma_{\omega,\omega\prime}(\nu) e^{-\sigma(\rho(i_\omega-\tau-\nu\zeta z)+c_{\omega'}(\nu)-(1+\rho)c_\omega(\nu))}\}. \tag{24}$$

To do this, we first note that for any a_t, the RHS of the Bellman equation can be written

$$e^{-\sigma\frac{\rho}{1+\rho}a_t} \max_{c_\omega(\nu)} -e^{-\sigma c_\omega(\nu)} - \frac{1}{\rho}\sum_{\omega\prime\in\Omega} \Gamma_{\omega,\omega\prime}(\nu) e^{-\sigma\rho(i_t-\zeta_t z-\tau-c_\omega(\nu))} e^{-\sigma c_{\omega'}(\nu)}$$

with a first-order-condition,

$$\begin{aligned} \sigma e^{-\sigma c_\omega(\nu)} &= \sigma \sum_{\omega\prime\in\Omega} \Gamma_{\omega,\omega\prime}(\nu) e^{-\sigma\rho(i_t-\zeta_t z-\tau-c_\omega(\nu))} e^{-\sigma c_{\omega'}(\nu)}, \\ 1 &= \sum_{\omega\prime\in\Omega} \Gamma_{\omega,\omega\prime}(\nu) e^{-\sigma(\rho(i_t-\zeta_t z-\tau)+c_{\omega'}(\nu)-(1+\rho)c_\omega(\nu)))}. \end{aligned}$$

Thus, (24) ensures that the first-order condition is satisfied. Then, substituting the consumption function and the first-order condition into the RHS of the Bellman equation yields,

$$\begin{aligned} & e^{-\sigma\frac{\rho}{1+\rho}a_t}\left(-e^{-\sigma c_\omega(\nu)} - \frac{1}{\rho}\sum_{\omega\prime\in\Omega} \Gamma_{\omega,\omega\prime}(\nu) e^{-\sigma\rho(i_t-\zeta_t z-\tau-c_\omega(\nu))} e^{-\sigma c_{\omega'}(\nu)}\right), \\ = \; & e^{-\sigma\frac{\rho}{1+\rho}a_t}\left(-e^{-\sigma c_\omega(\nu)} - \frac{1}{\rho} e^{-\sigma c_\omega(\nu)}\right), \\ = \; & -\frac{1+\rho}{\rho} e^{-\sigma\frac{\rho}{1+\rho}a_t} e^{-\sigma c_\omega(\nu)}, \end{aligned}$$

which is the LHS of the Bellman equation.

Clearly, ν is chosen so as to maximize expected welfare, which given (12) is equivalent to maximizing $c_\omega(\nu)$ over ν.

7.6.2 Characterization of consumption and saving

There exist no closed form solutions for the consumption constants c_ω but we can provide a close characterization of them. Consider first nonselective behavior, in which case a attached individual can become unattached, but never unemployed. Consumption and welfare is under nonselective behavior determined by the ratio of the value functions of a unattached and attached individual with the same level of assets, defined as

$$\Delta_{a,1} \equiv \frac{e^{\sigma c_n(1)}}{e^{\sigma c_a(1)}} = e^{\sigma(c_n(1)-c_a(1))}. \tag{25}$$

Using (25)the definition of $\Delta_{a,1}$ in (24) for $\nu = 1$ and $\omega = n, a$, it follows immediately that

$$\rho \ln \Delta_{a,1} + \ln\left((1-\alpha) + \alpha \Delta_{a,1}\right) = \ln\left((1-\gamma) + \gamma e^{\rho\sigma z} \Delta_{a,1}^{-1}\right) \tag{26}$$

$$\rightarrow z = \frac{\ln \Delta_{a,1} + \ln\left(\Delta_{a,1}^{\rho}\left((1-\alpha) + \alpha\Delta_{a,1}\right) - (1-\gamma)\right) - \ln\gamma}{\rho\sigma}$$

defining a strictly increasing relation between z and Δ_1, independent of τ, which we invert and denote $\Delta_{a,1}(z)$ with $\Delta_{a,1}(0) = 1$ and $\Delta_{a,1}'(z) > 0$. Now, using (25) and (26) in (24) we can write $c_a(1)$ as a function of z and τ;

$$c_a(1; z, \tau) = w - \tau - \frac{\rho \ln \Delta_{a,1}(z) + \ln\left((1-\alpha) + \alpha\Delta_{a,1}(z)\right)}{\sigma\rho},$$

which defining $s_{a,1}(z) \equiv \frac{\rho \ln \Delta_{a,1}(z) + \ln((1-\alpha)+\alpha\Delta_{a,1}(z))}{\sigma\rho}$ yields one of the equations in (13). Clearly, $s_{a,1}(z)$ increases in z and $s_{a,1}(0) = 0$, since $\Delta_{a,1}(0) = 1$.

Now, consider selective behavior, i.e., $\nu = 0$. In this case, a attached individual can become unemployed but not unattached and consumption and welfare is determined by the ratio between the value functions of attached employed and unemployed, defined as

$$\Delta_{a,0} \equiv \frac{e^{\sigma c_a(0)}}{e^{\sigma c_u(0)}} = e^{\sigma(c_a(0) - c_u(0))}. \tag{27}$$

Using (27 in (24) for $\nu = 0$ and $\omega = r, u$, it follows immediately that

$$\rho \ln \Delta_{a,0} + \ln\left((1-\gamma) + \gamma\Delta_0\right) - \sigma\rho w = \ln\left((1-\pi) + \pi\Delta_{a,0}^{-1}\right) - \sigma\rho b \tag{28}$$

$$\rightarrow w - b = -\frac{\ln\left((1-\pi) + \pi\Delta_{a,0}^{-1}\right) - \rho\ln\Delta_{a,0} - \ln\left((1-\gamma) + \gamma\Delta_{a,0}\right)}{\sigma\rho},$$

defining a strictly increasing and concave relation between $(w - b)$ and $\Delta_{a,0}$, independent of τ which we yields the strictly increasing and *convex* function $\Delta_{a,0}(w - b)$ with $\Delta_{a,0}(0) = 1$. Defining,

$$s_{a,0}(w-b) \equiv \frac{\ln\left((1-\gamma) + \gamma\Delta_{a,0}(w-b)\right)}{\sigma\rho}$$

and using (27) and (26) in (24) we can write $c_a(0)$ as a function of b and τ;

$$\begin{aligned} c_a(0; b, \tau) &= w - \tau - \frac{\ln\left((1-\gamma) + \gamma\Delta_{a,0}(w-b)\right)}{\sigma\rho} \\ &= w - \tau - s_{a,0}(w-b). \end{aligned}$$

To analyze the properties of $s_{a,0}(w-b)$, we note from (28) that

$$\begin{aligned} w-b &= -\frac{\ln\left((1-\pi)+\pi\Delta_{a,0}^{-1}\right)}{\sigma\rho}+\frac{\rho\ln\Delta_{a,0}}{\sigma\rho}+\frac{\ln\left((1-\gamma)+\gamma\Delta_{a,0}\right)}{\sigma\rho} \\ &= -\frac{\ln\left((1-\pi)+\frac{\pi\gamma}{e^{\sigma\rho s_{a,0}}-(1-\gamma)}\right)}{\sigma\rho}+\frac{\rho\ln\frac{e^{\sigma\rho s_{a,0}}-(1-\gamma)}{\gamma}}{\sigma\rho}+s_{a,0}, \end{aligned}$$

defining an increasing concave mapping from $s_{a,0}$ to $w-b$. Thus, the inverted relation, $s_{a,0}(w-b)$ is increasing and convex. It then follows that $c_a(0;b,\tau)$ is increasing and *concave* in b with $c_a(0;b,\tau)|_{b=w}=w-\tau$ and $\frac{\partial}{\partial b}c_a(0;b,\tau)|_{b=w}=\frac{\gamma}{\rho+\gamma+\pi}$.

Now, consider the unattached individuals. For nonselective behavior, (24) yields

$$\begin{aligned} c_n(1;z,\tau) &= w-\tau-\frac{1}{\sigma\rho}\ln\left(\alpha\Delta_{a,1}+(1-\alpha)\right), \quad (29) \\ &= c_a(1;z,\tau)+\frac{\ln\Delta_{a,1}(z)}{\sigma}, \end{aligned}$$

where we define $s_{n,1}(z)\equiv\frac{1}{\sigma\rho}\ln\left(\alpha\Delta_{a,1}+(1-\alpha)\right)$. Clearly, $c_n(1;z,\tau)$ is decreasing in z. For selective behavior, we define

$$\Delta_{n,0}\equiv e^{\sigma(c_n(0)-c_a(0))}.$$

Using (24) for $\omega=\{f,r\}$ and $\nu=0$, we get

$$\begin{aligned} & \gamma e^{-\sigma(\rho(w-\tau)+c_u(0)-(1+\rho)c_a(0))}+(1-\gamma)e^{-\sigma(\rho(w-\tau)+c_a(0)-(1+\rho)c_a(0))} \quad (30) \\ &= \alpha e^{-\sigma(\rho(w-\tau)+c_a(0)-(1+\rho)c_n(0))}+(1-\alpha)e^{-\sigma(\rho(w-\tau)+c_n(0)-(1+\rho)c_n(0))} \quad (31) \\ \gamma\Delta_{a,0}+1-\gamma &= \Delta_{n,0}^{\rho}\left(\alpha\Delta_{n,0}+(1-\alpha)\right) \\ \Delta_{a,0} &= \frac{\Delta_{n,0}^{\rho}\left((1-\alpha)+\alpha\Delta_{n,0}\right)}{\gamma}-\frac{1-\gamma}{\gamma}. \end{aligned}$$

defining an increasing relation between $\Delta_{a,0}$ and $\Delta_{n,0}$, which inverted yields the strictly increasing function $\Delta_{n,0}=\Delta_{a,0}=\Delta_{a,0}(w-b)$. Using this in (24) yields,

$$\begin{aligned} c_n(0;b,\tau) &= w-\tau-\frac{1}{\sigma\rho}\ln\left(\alpha\Delta_{n,0}+(1-\alpha)\right), \quad (32) \\ &= c_a(0;b,\tau)+\frac{\ln\Delta_{n,0}(w-b)}{\sigma} \quad (33) \end{aligned}$$

where we define

$$s_{n,0}(w-b)\equiv\frac{1}{\sigma\rho}\ln\left(\alpha\Delta_{n,0}(w-b)+(1-\alpha)\right).$$

Taking the log of the second line of (30), dividing by $\sigma\rho$ and using the definitions of the savings functions, we have

$$s_{a,0} = s_{n,0} + \frac{\rho \ln \frac{e^{\sigma\rho s_{n,0}} - (1-\alpha)}{\alpha}}{\sigma\rho}.$$

Similarly, we have

$$s_{a,1}(z) = s_{n,1}(z) + \frac{\rho \ln \frac{e^{\sigma\rho s_{n,1}} - (1-\alpha)}{\alpha}}{\sigma\rho}.$$

For $\nu \in \{0, 1\}$,

$$\begin{aligned} \frac{ds_{a,\nu}}{ds_{n,\nu}} &= 1 + \rho \frac{e^{\sigma\rho s_{n,\nu}}}{e^{\sigma\rho s_{n,\nu}} - (1-\alpha)} > 0, \\ \frac{d^2 s_{a,\nu}}{ds_{n,\nu}^2} &= -\rho^2 \sigma e^{\sigma\rho s_{n,\nu}} \frac{1-\alpha}{\left(e^{\sigma\rho s_{n,\nu}} - (1-\alpha)\right)^2} < 0 \end{aligned}$$

defining an increase and concave mapping from $s_{n,\nu}$ to $s_{a,\nu}$, which inverted yields $s_{n,\nu}$ as increasing *convex* function of $s_{a,\nu}$, passing through origo, where the slope is $\frac{1}{1+\frac{\rho}{\alpha}}$ and with an asymptotic slope $\frac{1}{1+\rho} < 1$. Thus,

1. the savings of the unattached is always lower than that of the attached, and
2. the savings of the unattached is less sensitive to b or z than that of the attached.

Furthermore, since $s_{n,0}$ is a convex increasing function of $s_{a,0}$ passing through origo and $s_{a,0}(w-b)$ is a function with the same properties, we can write $s_{n,0} = s_{n,0}(w-b)$ as a convex increasing function passing through origo. Therefore, $c_n(0; b, \tau)$ is increasing and concave in b.

Finally, let us show that $c_a(0) \geq c_a(1) \Leftrightarrow c_n(0) \geq c_n(1)$ Using the second lines of (29) and (32) we have

$$c_a(0) \geq c_a(1),$$
$$c_n(0) - \frac{\ln \Delta_{n,0}(b)}{\sigma} \geq c_n(1) - \frac{\ln \Delta_{a,1}(z)}{\sigma},$$
$$w - \tau - \frac{\ln(\alpha \Delta_{n,0}(w-b) + (1-\alpha))}{\sigma\rho} - \frac{\ln \Delta_{n,0}(b)}{\sigma}$$
$$\geq w - \tau - \frac{\ln(\alpha \Delta_{a,1}(z) + (1-\alpha))}{\sigma\rho} - \frac{\ln \Delta_{a,1}(z)}{\sigma},$$
$$\Delta_{n,0}(w-b) \leq \Delta_{a,1}(z),$$
$$w - \tau - \frac{\ln(\alpha \Delta_{n,0}(w-b) + (1-\alpha))}{\sigma\rho} \geq w - \tau - \frac{\ln(\alpha \Delta_{a,1}(z) + (1-\alpha))}{\sigma\rho},$$
$$c_n(0) \geq c_n(1).$$

7.6.3 Aggregate law-of-motion and taxes

Consider, next, how the introduction of stochastic death affects the dynamics of the distribution of types. The modified law of motion is $\mu_t = [(1-\delta)\Gamma(\nu_a) + \Delta]\mu_{t-1}$ where

$$\Delta \equiv \begin{bmatrix} 0 & \delta & 0 \\ 0 & \delta & 0 \\ 0 & \delta & 0 \end{bmatrix}$$

and $\Gamma(\nu_a)$ is as in (2). Using standard methods, we find that the resulting long-run distributions under selective and nonselective behavior, respectively, are

$$\begin{aligned} \mu^s(0) &= \left\{ \frac{\alpha}{\alpha+\eta}\frac{\pi+\eta}{\gamma+\pi+\eta}, \frac{\eta}{\alpha+\eta}, \frac{\alpha}{\alpha+\eta}\frac{\gamma}{\eta+\pi+\gamma} \right\} \\ \mu^s(1) &= \left\{ \frac{\alpha}{\gamma+\alpha+\eta}, \frac{\gamma+\eta}{\gamma+\alpha+\eta}, 0 \right\} \end{aligned}$$

where $\eta \equiv \frac{\delta}{1-\delta}$. We assume that the government lends at borrows at a rate r. Its intertemporal budget constraint is, then,

$$\tau \frac{1+r}{r} = b \sum_{t=0}^{\infty} u_t (1+r)^{-s},$$

where $u_t = 0$ under nonselective behavior and

$$\begin{aligned} u_t &= u^s + (u_0 - u^s)((1-\delta)(1-\pi-\gamma))^t \\ &\quad - \left(f_0 - f^{s,0}\right)\frac{\gamma}{\pi+\gamma-\alpha}\left(((1-\delta)(1-\alpha))^t - ((1-\delta)(1-\pi-\gamma))^t\right), \end{aligned}$$

where $u^s \equiv \frac{\alpha}{\alpha+\eta}\frac{\gamma}{\eta+\pi+\gamma}$, and $f^{s,0} \equiv \frac{\eta}{\alpha+\eta}$. Using the solution for u_t in the intertemporal budget constraint yields,

$$\begin{aligned}\tau &= b\Bigg[u^s + (u_0 - u^s)\frac{r}{r+\delta+(\pi+\gamma)(1-\delta)} \\ &\quad - \left(f_0 - f^{s,0}\right)\frac{\gamma(1-\delta)r}{(r+\delta+(\pi+\gamma)(1-\delta))(r+\delta+\alpha(1-\delta))}\Bigg].\end{aligned}$$

implying

$$\begin{aligned}&T_E = u^s, \\ &T_A = u^s\left(1 - \frac{r}{r+\delta+(\pi+\gamma)(1-\delta)}\right)\left(1 - \frac{1}{(\delta+(\alpha+\gamma)(1-\delta))}\frac{\gamma(1-\delta)r}{(r+\delta+\alpha(1-\delta))}\right) < T_E.\end{aligned}$$