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Abstract

This paper compares the decentral organization of unemployment insurance in member states of a state union with the central organization at the upper union' level. In a model of two countries the labor force and the firm owners can migrate between the states. Labor markets exhibit unemployment due to trade union's bargaining about the wage rate. In a decentral scenario the states organize independently unemployment insurance and decide about the rate on wages contributed to the insurance budget. Due to open borders they have to take account of migration effects. However, with perfect mobility between the states each government chooses a socially optimal contribution rate such that workers are fully insured against unemployment. In the central scenario the governments overestimate the costs of insurance when bargaining about the contribution rate and observing the common insurance budget of both countries. This leads to a less than socially optimal contribution rate.

JEL-Codes: F660, H770, J650.

Keywords: unemployment insurance policy, state union, centralization, migration externalities.

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1 Introduction

Should social security systems of member states in a state union be centralized or remain in the single country's competence? Issues as migration or fiscal externalities of a common budget play a central role in answering this question. In the European Union once and again the centralization of a European public unemployment insurance has been proposed and discussed (Beblavỳ and Lenaerts (2017), Andor et al. (2014)). Recently, the French prime minister argued in favor of a common European unemployment insurance in order to redistribute in "a social way" transfers from economically more successful countries to less successful ones. However, if a persistent subsidization and therefore ex ante redistribution is to be avoided, a certain degree of symmetry is required across the participating countries. Otherwise, the insurance aspects will be augmented with distributional considerations.

In this paper we compare the efficiency of a central organization of the unemployment insurance at the state union's level with a decentral organization in the countries. In the model two countries form a state union. In both countries labor markets are governed by the bargaining of trade unions and firms about the wage rate. An individual of the labor force can be employed or unemployed with a probability which is given by the relation of the number of workers or unemployed to the total size of the labor force (Harris and Todaro (1970)). The labor force is insured against unemployment by a public insurance which pays a benefit. The government determines the contribution rate on wages in order to finance the insurance budget. The labor force as well as the firm owners in both countries can migrate between the states.

First the social optimum is defined and analyzed. The social planner considers a unitary state without borders and has complete discretion about wages, employment and the unemployment insurance system. We find that an actuarially fair contribution rate is optimal which is equal to the unemployment rate and where net wage income equals the unemployment benefit. Hence, the labor force is fully insured against unemployment. Under the condition of this optimal contribution rate the social planner then chooses full employment of the labor force.

Second the autarkic case is analyzed where both countries have separate unemployment insurances, borders are closed and no migration takes place. In this scenario we find that governments set the socially optimal contribution rate such that workers are fully insured against unemployment. However, this turns out to be true as long as the representation of both groups of labor force and firms in the welfare function of the government is the same as in the Nash-bargaining function of the trade union and the firms when bargaining about the wage rate. Thus a misrepresentation effect arises if the weights of the government differ from the weights of bargaining power which may lead to over- or underinsurance.

Third we allow for migration between the countries. The response of migrating individuals of the labor force as well as firm owners is taken into account by the government when choosing the unemployment contribution rate. Neglecting the misrepresentation effect, with full mobility of all societal groups and symmetric countries the governments choose the socially optimal contribution rate. All migration externalities are internalized by the decentral governments as long as there are no migration costs. However, if one of the groups, labor force or firms, is imperfectly mobile the decentral decision leads no longer to an actuarially fair contribution rate. E.g. if only workers are fully mobile, the migration externality induces underinsurance of households so that the contribution rate is lower than the socially optimal one. Furthermore we can show that migration externalities are not fully internalized as long as the degree of mobility differs between the societal groups. The group which is less mobile will be more favored by the governmental decisions about the unemployment insurance because a larger part of that group is represented in the welfare function whereas the other more mobile group evades the policy and migrates to the other country to a larger extent.

Fourth a central organization of unemployment insurance at the state union level is analyzed. Here the households of both countries pay contributions into a common budget of unemployment insurance at the same rate negotiated by the two governments. The unemployment benefit is the same for all unemployed in the state union. In the negotiations the governments maximize the sum of welfare functions of both countries. In doing this they overestimate the effect of a change of the contribution rate in the common insurance budget (the common budget effect). Hence a rate lower than the fair one is bargained. Underinsurance occurs in comparison with the socially optimal case. The comparison of the decentral and the central organization of unemployment insurance shows that the degree of mobility of the labor force and the firms makes the difference. With perfect mobility of both groups the decentral organization of unemployment insurance is - apart from the misrepresentation effect - socially optimal while the central organization leads to an underinsurance. If migration costs are relevant and one of the groups is less mobile than the other one the decentral governments choose either a lower (households are more mobile) or a higher contribution rate (firms are more mobile) than would be actuarially fair. With imperfect mobility the superiority of decentralization versus centralization depends of the size of the migration externalities compared to the common budget effect.

The misrepresentation effect, the migration effect, and the common budget effect that drive the results for the autarchic, decentral or central organization of unemployment insurance hinge essentially on our assumption of imperfect labor markets. Since the effect that in a labor market with trade unions the increase in the contribution rate causes a higher negotiated gross wage is essential for all results. This is an important difference to interregional models with mobile workers in integrated perfect labor markets.

The paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 describes the model. Section 4 determines the social optimum. Section 5 considers autarky and the misrepresentation effect. Section 6 allows for migration and calculates the decentral solution for unemployment insurance. At first the case of perfect mobility of households and firms is considered. Then migration costs are introduced in the model and the effects of imperfect mobility of firms and/or households are analysed. In section 7 the central decision about a uniform unemployment insurance for both countries is examined and the common budget effect is presented. Section 8 concludes.

2 Literature review

This paper is related to the economic analysis of fiscal federalism, in particular to questions about the optimal allocation of redistributive governmental functions. Standard models within this strand of literature are typically characterized by a perfect labor market and an (un)restrained interregional mobility of transfer recipients and payers. The efficiency conditions of a decentralized allocation of governmental functions are compared with the outcomes of a unitary state that has access to a set of uniform tax and transfer instruments (see e.g. Wildasin (1991), Wellisch (1995), Kolmar (1999), Wellisch (2000)). In the sense of Oates (1972), it is usually argued that the government of the unitary state should care for redistributive issues due to adverse selection problems of local governments. However, in the context of e.g. European economic unification as promoted by Juncker et al. (2015), a unitary state is unlikely to be a plausible subject of reference. Instead, it is more reasonable to consider the degree of (de)centralization in terms of the governmental ability to raise own tax revenues (see Boadway (2006)). Therefore, in our paper we consider the (de)centralization of social security budgets rather than a (de)centralization of jurisdictions. Within a state union with a fixed number of regions, two polar cases are investigated. First local contribution rates and benefits are organized independently by local governments. Second uniform contribution rates and benefits are subject of negotiations between the local governments.
As noted by Hillman (2003), a government provides social insurance if it redistributes income to maximize social welfare. In the special case of unemployment risk and homogenoeus individuals the central or the decentral governments redistribute income ex post, because an individual may find itself in two different states of the world, being unemployed or employed. Integrating endogenous unemployment probabilities into models of fiscal competition is achieved e.g. by considering imperfect labor markets with minimum wages (see Lozachmeur (2003)) or labor markets characterized by trade unions (see Lejour and Verbon (1996), Sanner (2003), Saha and Schöb (2015)). In the latter case, compared to a competitive labor market the respective central or local governments have to consider an additional economic subject and its behavioral responses when maximizing social welfare. Different constellations of interaction between the government and the trade union may occur, which can be distinguished as follows: (de)centralized Ghent systems where trade unions are directly involved in organizing the unemployment insurance (see Holmlund and Lundborg (1988)) and pure governmental social insurance. The difference between a centralized and a decentralized Ghent system is the level at which bargaining takes place, local or region/ industry wide. The majority of unemployment insurance in most European countries though is organized by the government, but collective wage bargaining is of relevance in each of those countries (see Boeri, Brugiavini, and Calmfors (2001)). Therefore, in our paper we consider governments which determine the contribution rates and benefit levels while the trade unions do only engage in wage negotiations.

Our paper is closest to the work of Lozachmeur (2003), who considers fiscal competition in a framework similar to Harris and Todaro (1970). In contrast to Lozachmeur (2003) we consider pure wage income taxation and unemployment caused by trade unions. In this setting and for symmetric regions with full mobility, we cannot confirm his result of a suboptimal low level of decentralized unemployment insurance. Furthermore, we additionally consider a centralized scenario, where we find suboptimal levels of unemployment insurance.

3 The model

The state union consists of two states, $i = 1,2$ and is inhabited by N identical workers and M identical firm owners. All individuals live in one of the two states such that

$$N = n^1 + n^2 \tag{1}$$

$$M = m^1 + m^2 \tag{2}$$

with n^i for the number of workers and m^i for the number of firm owners in state i.

3.1 Labor force

Each worker is endowed with one unit of labor inelastically supplied in the state of residence. The n^i workers living in state i are divided in the subgroup of the employed l^i and the unemployed u^i

$$N = l^1 + u^1 + l^2 + u^2$$

Following Harris and Todaro (1970), the probabilities of being employed e^i and being unemployed $(1 - e^i)$ are defined as follows

$$e^i = \frac{l^i}{n^i} \tag{3}$$

$$1 - e^i = \frac{u^i}{n^i} = \frac{n^i - l^i}{n^i} \tag{4}$$

Ex ante, the individuals do not know their labor market status. If they are employed they receive a net wage $\tilde{w}^i = w^i \left(1 - t^i\right)$ where w^i represents the gross wage and t^i the contribution rate to the social security system. If the individuals are unemployed they receive an unemployment benefit b^i. With their income, either net wage or benefit, individuals finance consumption. The utility they draw from consumption is represented by a monotone and strictly concave function $U(\cdot)$. The expected utility EU^i of the representative individual living in state i is given by:

$$EU^i = \frac{l^i}{n^i} U(w^i(1 - t^i)) + \frac{n^i - l^i}{n^i} U(b^i)$$

In the following we assume that individuals are risk averse and prefer to be insured against the risk of unemployment. Therefore, the utility function U is characterized by a value of relative risk aversion $\sigma > 0$.[1]

3.2 Firm owners

Production in either state uses a technology that is characterized by a continuous, strictly increasing and strictly concave function $f(l^i)$ with $f(0) = 0$. The total profit in state i is given by

$$\pi^i = f(l^i) - w^i l^i \tag{5}$$

and the optimal usage of the the labor input is obtained from the first order condition of profit maximization

$$w^i \overset{!}{=} f_{l^i}(l^i) \tag{6}$$

Optimal labor demand $l^i(w^i)$ is defined by the inverse function of condition (6) with a corresponding (short run) own wage elasticity $\eta_{l,w} = \frac{\partial l(w)}{\partial w}\frac{w}{l} < 0$. The total profit in state i is distributed among the m^i firm owners such that each firm owner receives the share $\Pi^i = \frac{\pi^i}{m^i}$, yielding an utility of

$$E\Pi^i = U\left(\frac{\pi_i}{m^i}\right) \tag{7}$$

3.3 Migration

Individuals migrate or change the location of their firms as long as their expected utility differs between the states. They move to the state in which they have a higher utility. The migration equilibrium is given when utilities are equalized. At the outset, for the sake of simplicity, individuals are characterized by perfect inter-regional mobility. Later on we will show the implications of migration cost. For now the migration equilibria for workers and firm owners are characterized by the two conditions

$$EU^1 - EU^2 = 0 \tag{8}$$

$$E\Pi^1 - E\Pi^2 = 0 \tag{9}$$

3.4 Government

The governments collect revenue for the unemployment insurance via a proportional contribution rate on labor income and pay out of this budget a benefit to each of the unemployed. After determining the social optimum we analyse in the following three governmental regimes. The first regime applies to states with autarkic economies and closed borders. There is no migration. The

[1] The value of relative risk aversion is defined as $\sigma = -x\frac{U_{xx}}{U_x}$. For partial derivatives of a function $y(x)$ we use the shorthand notation $y_x := \partial y / \partial x$.

second regime characterizes decentralized states with open borders and with economies in an integrated labor market where workers and firm owners are mobile. In both regimes, each government runs its own budget and sets a country specific contribution rate t^i and unemployment benefit b^i such that

$$b^i = w^i t^i \frac{l^i}{n^i - l^i} \tag{10}$$

with $i = 1,2$. In the first regime n^i and m^i are constant whereas in the second regime they are determined by the migration equilibria (8) and (9). The third regime considers a state union with governments negotiating over a uniform contribution rate t and benefit b for both countries so that the budget is given by:

$$b = t\frac{w^1 l^1 + w^2 l^2}{N - l^1 - l^2} \tag{11}$$

As in the decentralized regime, borders are open and migration is possible. In the following we assume that the government(s) choose(s) the contribution rate of unemployment insurance in order to maximize welfare. The contribution rate is actuarially fair, if $t^* = \frac{n^i - l^i}{n^i}$ holds.[2] The benefits b^i and b are determined as residuals from the budget which has to be balanced.

3.5 Wage negotiations

The labor market is characterized by unemployment. This enters the model by implementing right-to-manage Nash bargaining between the representative firm and a trade union. It is assumed that union membership in country i encompasses all workers n^i. The trade union knows the budget of the government, and takes as given the contribution rate t^i as well as membership n^i. The outside options $\overline{EU^i}$ and $\overline{E\Pi^i}$ of both negotiators are normalized to zero (see also Fuest and Huber (1999)). Furthermore, the Nash bargaining function $\Psi^i = (E\Pi^i(w^i) - \overline{E\Pi^i})^{1-g^i}\left(EU^i(w^i) - \overline{EU^i}\right)^{g^i}$ comprises weights of bargaining power g^i of the labor force and $1-g^i$ of the firms with $0 < g^i \leq 1$. It is maximized, if the following logarithmic function is maximized:

$$\begin{aligned}\max_{w^i} \ln \Psi^i = (1-g^i)\ln U\left(\frac{f(l^i(w^i)) - w^i l^i(w^i)}{m^i}\right) \\ + g^i \ln\left(\frac{l^i(w^i)}{n^i}\left[U(\tilde{w}^i(w^i)) - U(b^i(w^i, l(w^i)))\right] + U(b^i(w^i, l(w^i)))\right)\end{aligned} \tag{12}$$

where $\tilde{w}^i(w^i)$ is the net wage as function of the gross wage and $b^i(w^i, l(w^i))$ is the unemployment benefit resulting from the respective governmental budget (10) or (11). The first order condition is given by

[2] A fair contribution rate implies an equalization of utilities between individuals, irrespective of their labor market status: $U(\tilde{w}^i) = U(w^i(1-t^*)) = U\left(w^i \frac{l^i}{n^i}\right) = U\left(w^i t^* \frac{l^i}{n^i - l^i}\right) = U(b^i)$. The same holds for a central budget with symmetric regions. See Hillman (2003) for a short overview about the justification of different social insurance objectives.

$$\frac{\partial \ln \Psi^i}{\partial w^i} = (1-g^i)\frac{U_{\Pi^i}\frac{1}{m^i}(l^i_{w^i}(\pi^i_{f^i}f^i_{l^i}+\pi^i_{l^i})+\pi^i_{w^i})}{U(\Pi^i)}$$
$$+g^i\frac{l^i_{w^i}[U(\tilde{w}^i)-U(b^i)]+l^iU_{\tilde{w}^i}\tilde{w}^i_{w^i}+(n^i-l^i)U_{b^i}\left[b^i_{w^i}+b^i_{l^i}l^i_{w^i}\right]}{l^i[U(\tilde{w}^i)-U(b^i)]+n^iU(b^i)} \stackrel{!}{=} 0 \tag{13}$$
$$= (1-g^i)\frac{E\Pi^i_{w^i}}{E\Pi^i}+g^i\frac{EU^i_{w^i}}{EU^i} \stackrel{!}{=} 0 \tag{14}$$

This condition determines the negotiated wage rate $w^i\left(t^i\right)$. The response of the optimal wage rate to an increase of the contribution rate fulfills $w^i_{t^i} > 0$, if the direct effect of the tax increase on the level of expected worker utility is relatively smaller than the indirect effect via the wage rate: $\frac{EU_t}{EU} < \frac{EU_{wt}}{EU_w}$. For the case of an actuarially fair contribution rate t^*, we can show that this condition unambiguously holds for risk averse households, given that a unique maximum exists ($\ln \Psi_{ww} < 0$).[3] Under those circumstances, a higher contribution rate induces trade unions to bargain for a higher gross wage in order to compensate workers for the net wage loss.

3.6 Sequence of decisions

The model is solved backwards. At the first stage, the government decides about the contribution rate t^i or t which maximizes a social welfare function depending on the regimes above. This will be outlined in the following sections. All other endogenous variables are known and taken into account by the government, including migrational responses. At the second stage, the trade union takes as given the contribution rate as well as the number of individuals residing in country i when bargaining with the firm over the wage rate. If the wage is determined, the firm decides at the third stage about the number of workers it wishes to employ. Finally, at the fourth stage the individuals compare net wages and benefits between both countries, form expectations and decide whether to migrate to the other state or not. Table 1 summarizes the sequence of decisions.

Table 2: Sequence of decisions

Stage	Decision
1	Government: t
2	Wage bargaining: w
3	Firm owners: l
4	Individuals: n, m

4 Social optimum

The social optimum is characterized by a social planner who chooses directly the level of wages, the level of employment and the extent of unemployment insurance while observing the budget

[3] See appendix, Lemma 1.

equation (10) in a unitary state. The social planner maximizes the Bernoulli-Nash social welfare function $V = (E\Pi)^{1-x}(EU)^{x}$ via the policy parameters w, l and t.[4] The welfare function weights the utility of firm owners by $(1-x)$ and the expected income of workers by x. Accordingly, the following logarithmic function is maximized wih respect to the constraint $l \leq n$:

$$\max_{t,w,l} \ln V = (1-x)\ln U\left(\frac{f(l)-wl}{m}\right) + x\ln\left(\frac{l}{n}U(\tilde{w}(w,t)) + \frac{n-l}{n}U(b(l,w,t))\right)$$

The first order conditions are given by:

$$\frac{\partial \ln V}{\partial t} = \frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t \stackrel{!}{=} 0 \tag{15}$$

$$\frac{\partial \ln V}{\partial w} = (1-x)\frac{U_{\Pi}\frac{1}{m}\pi_w}{E\Pi} + x\frac{\frac{l}{n}U_{\tilde{w}}\tilde{w}_w + \frac{n-l}{n}U_b b_w}{EU} \stackrel{!}{=} 0 \tag{16}$$

$$\frac{\partial \ln V}{\partial l} = (1-x)\frac{U_{\Pi}\frac{1}{m}(\pi_f f_l + \pi_l)}{E\Pi} + x\frac{\frac{1}{n}(U(\tilde{w}) - U(b)) + \frac{n-l}{n}U_b b_l}{EU} \stackrel{!}{=} 0 \tag{17}$$

Equation (15) implies $U_b(b(t)) = U_{\tilde{w}}(\tilde{w}(t))$, which implies $b(t) = \tilde{w}(t)$. Then, the optimal tax rate is actuarially fair and given by

$$t^{sp} = \frac{n-l}{n}, \tag{18}$$

which equalizes the income and the utility of the employed and the unemployed. The contribution rate t is the policy instrument to redistribute income within the group of workers. Due to the assumption of identical, smooth and concave utility functions, the equalization of income via t characterizes complete intra-group redistribution between employed and unemployed workers. In contrast to the contribution rate t, the wage rate w serves as an instrument to redistribute income between the group of workers and firm owners. Conditional on the fair contribution rate, the optimal degree of inter-group redistribution is determined by first order condition (16). Substituting condition (18) into equation (16) yields

$$x\frac{U_b}{EU}\frac{1}{n} = (1-x)\frac{U_{\Pi}}{E\Pi}\frac{1}{m}. \tag{19}$$

In the optimum the weighted relative gain of workers by a wage increase is equalized with the weighted relative loss of firm owners. Obviously, the optimal redistribution between groups is dependent on the weights of the social preferences and the ratio of workers and firm owners.
Finally, substituting the conditions (18) and (19) into the first order condition for the optimal level of l, condition (17), we obtain

$$f_l = 0, \tag{20}$$

which implies that the social planner chooses full employment of the labor force, $l = n$, because $l \leq n$ must hold. This means that the social planner maximizes the production conditional on

[4] The Bernoulli-Nash social welfare function is chosen, because it allows for direct comparability between the first order conditions of the different scenarios, in particular with respect to results derived from Nash-bargaining.

optimal intra- and inter-group redistribution such that social welfare is maximized.

Furthermore, the social planner does always choose a higher level of employment at a higher level of wages compared to the outcome of wage negotiations on the imperfect labor market.[5] This reason is that the optimization of the social planner with respect to l and w is comparable to efficient bargaining, with the only difference lying in the interpretation of the parameters for social preferences, x and for the bargaining power, g.

As the assumptions about the labor market conditions do not differ between the regimes considered in the rest of the paper, only the first order condition (15), which concerns the unemployment insurance, is of relevance in the following.

5 Autarky

In the autarkic regime with no migration, the government maximizes the Bernoulli-Nash social welfare function $V = (E\Pi)^{1-x}(EU)^x$ via its policy parameter t. It puts weight $(1-x)$ on the profit of firm owners and weight x on the expected income of workers. Accordingly, the government maximizes the logarithmic function

$$\max_t \ln V = (1-x)\ln U\left(\frac{f(l(w(t))) - w(t)l(w(t))}{m}\right)$$
$$+ x\ln\left(\frac{l(w(t))}{n}\left[U(\tilde{w}(w(t),t)) - U(b(l(w(t)),w(t),t))\right] + U(b(l(w(t)),w(t),t))\right) \quad (21)$$

The first order condition is given by

$$\frac{\partial \ln V}{\partial t} = w_t\Bigg((1-x)\frac{U_\Pi \frac{1}{m}(l_w(\pi_f f_l + \pi_l) + \pi_w)}{E\Pi}$$
$$+ x\frac{l_w[U(\tilde{w}) - U(b)] + lU_{\tilde{w}}\tilde{w}_w + (n-l)U_b\left[b_w + b_l l_w\right]}{l\left[U(\tilde{w}) - U(b)\right] + nU(b)}\Bigg)$$
$$+ x\frac{\frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t}{EU} \stackrel{!}{=} 0 \quad (22)$$

Substituting equation (14) into (22) yields

$$\frac{\partial \ln V}{\partial t} = \frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t + E\Pi_w w_t\left(\frac{1-x}{x} - \frac{1-g}{g}\right)\frac{EU}{E\Pi} \stackrel{!}{=} 0 \quad (23)$$

Compared to the social optimum and the respective first order condition (15) an additional term appears in equation (23): $E\Pi_w w_t\left(\frac{1-x}{x} - \frac{1-g}{g}\right)\frac{EU}{E\Pi}$. This term can be called the *misrepresentation effect*. The government chooses weights for the working population x and the firm owners $(1-x)$ in the welfare function. These weights may represent the societal importance of those groups. In particular, the weights may indicate the social power of the groups to negotiate e.g. the wage on

[5] See appendix, Lemma 2.

the labor market. However, the government may be mistaken about this social power. It may value the representation of the labor force, the trade union - or the firm owners - as more or less powerful than they are in reality. In this case of misrepresentation the governmental weight assigned to the social groups differs from the real bargaining power of those groups: $x \neq g$. Then, the income tax rate serves two purposes. First, it redistributes between the employed and the unemployed. Second, it redistributes between workers and firm owners.

Assuming $x = g$ the misrepresentation effect vanishes and using the derivatives of the net wage and the benefit given by (10) the condition (23) boils down to $U_{\tilde{w}}(\tilde{w}(t)) = U_b(b(t))$, which implies that the autarkic government sets an actuarially fair contribution rate and provides full insurance against unemployment.

Now consider the case that the government misrepresents the social groups in its welfare function. Proceeding from the case of full insurance and assuming that the government assesses the societal power of the trade union (labor force) as higher than it is: $x > g$ the misrepresentation effect has a positive sign due to $w_t > 0$ and $E\Pi_w < 0$, when evaluated at the fair contribution rate.[6] Hence, $U_{\tilde{w}} > U_b$ and $b > w(1-t)$. The government chooses a contribution rate for the unemployment insurance which is more than actuarially fair: $t^a > \frac{n-l}{n}$. In this case, the government overinsures the individuals against unemployment, because the negotiated wage rate appears to be too low for the government. If it had complete discretion about the level of wages, it would set a higher wage rate to maximize social welfare. However, with wage negotiations on the labor market, this can be achieved only indirectly by adjusting the tax rate upwards. For $x < g$, the opposite holds true.

Proposition 1. *In an autarkic economy without migration, if the government uses the bargaining power as weights in the welfare function ($x = g$) the optimal unemployment insurance is given by the actuarially fair contribution rate equal to the probability of being unemployed. If the misrepresentation effect arises the government overinsures ($x > g$) or underinsures ($x < g$) the labor force against unemployment.*

6 Decentralized tax and benefit

6.1 Perfect mobility

In the decentralized regime, the governments in each region take into account the potential effects of tax rate adjustments on migration. This is the only difference when comparing the behavior of decentralized governments with that of autarkic governments. The migration responses of workers, $n(t)$, and firms, $m(t)$, are implicitly determined by the migration equilibria (8) and (9).[7] Accordingly, the objective function looks similar to equation (21), but additionally considers $n(t)$ and $m(t)$:

[6] See appendix, Lemma 1 and Lemma 3.
[7] See appendix, Lemma 4 and Lemma 5.

$$
\begin{aligned}
\max_t \ln V = (1-x)\ln U\left(\frac{f(l(w(t))) - w(t)l(w(t))}{m(t)}\right) \\
+ x\ln\left(\frac{l(w(t))}{n(t)}\left[U(\tilde{w}(w(t),t)) - U(b[l(w(t)),n(t),w(t),t])\right]\right. \\
\left. + U(b[l(w(t)),n(t),w(t),t])\right)
\end{aligned}
\tag{24}
$$

The first order condition is given by:

$$
\begin{aligned}
\frac{\partial \ln V}{\partial t} = w_t\left((1-x)\frac{U_\Pi \frac{1}{m}(l_w(\pi_f f_l + \pi_l) + \pi_w)}{E\Pi}\right. \\
\left. + x\frac{l_w[U(\tilde{w}) - U(b)] + lU_{\tilde{w}}\tilde{w}_w + (n-l)U_b\left[b_w + b_l l_w\right]}{l\left[U(\tilde{w}) - U(b)\right] + nU(b)}\right) \\
+ x\frac{\frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t}{EU} \\
- x\frac{\frac{l}{n^2}[U(\tilde{w}) - U(b)] - \frac{n-l}{n}U_b b_n}{EU}n_t \\
+ (1-x)\frac{U_\Pi \Pi_m}{E\Pi}m_t \stackrel{!}{=} 0
\end{aligned}
\tag{25}
$$

with $n_t \geq 0$ and $m_t < 0$.[8] Compared to the condition of the social planner (15), two additional terms appear in condition (25) besides the misrepresentation effect. These last two terms in (25) describe the welfare effects of the migrational responses due to contribution rate adjustments. For symmetric regions and perfect mobility of firm owners and workers, migration has the same relative effect on the costs and benefits generated by an increase of the contribution rate.[9] This holds, because due to full mobility any gain or loss from a change in the contribution rate is equally shared between the two economies as shown in the following. Taking into account the optimality condition of wage negotiations (14) the first order condition then simplifies and is equivalent to the autarkic decision on t:

$$
\frac{\partial \ln V}{\partial t} = \left(\frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t + E\Pi_w w_t\left(\frac{1-x}{x} - \frac{1-g}{g}\right)\frac{EU}{E\Pi}\right)\left(1 - \frac{1}{2}\right) \stackrel{!}{=} 0 \tag{26}
$$

Proposition 2. *In a decentralized economy with migration and perfect mobility, if the government uses the bargaining power as weights in the welfare function ($x = g$) it sets an actuarially fair contribution rate such that workers are fully insured against unemployment.*

Condition (26) shows that the migrational terms in condition (25) are each exactly one half of the costs and benefits incurred or gained by an increase of the contribution rate. Each migrational effect is the product of the impact of the contribution rate increase on the number of inhabitants,

[8]See appendix, Lemma 4 and Lemma 5.

[9]See appendix, Lemma 6, Lemma 7 and Lemma 8.

m_t or n_t, and the impact of a change of the number of inhabitants on the expected utilities EU_n or $E\Pi_m$. Due to the assumption of symmetry, the decrease of expected utility in region 1 from one more inhabitant n^1 or m^1 is equal to the increase of expected utility in region 2 from one inhabitant n^1 or m^1 less: e.g. $EU^1_{n^1} - EU^2_{n^2}\frac{\partial n^2}{\partial n^1} = 0$.[10] Therefore, any expected gain or loss by a policy measure in region i is equally shared by the other region, because the effect of the policy measure on the number of inhabitants cushions the impact on the expected utility in region i. This implication, which occurs due to full mobility, holds for firm owners and for workers. Therefore, each migrational term in condition (25) decreases the effect of a contribution rate increase on the expected utility, either EU or $E\Pi$, equally by one half such that the government decision (26) remains undistorted.

Provided that welfare weights of decentral governments and the bargaining power of trade unions are alligned this result shows that perfect mobility of households and firms is sufficient to achieve the socially optimal allocation. This result - well-known for interregional migration with perfect labor markets - is also obtained in our model with imperfect labor markets. Decentral governments internalize the migration externalities and choose a policy that fully insures workers against unemployment. However, this is not the case if migration costs arise.

6.2 Imperfect mobility

Migration externalities in a regime of decentral governments are not fully internalized if migration of workers or firms incurs expenses. E.g. assume that the labor force is completely immobile. This immobile group gets a higher weight in the welfare function of the government than this other mobile group, the firms, because part of the latter group migrates out of the state and so the group is only partially affected by government action. For that reason the insurance policy is modified to accommodate the immobile group. This gives rise to welfare losses and the socially optimal allocation is no longer achieved by the governmental policy. In the following we outline the impact of migration costs for firms included in our model.

Consider symmetric regions and assume that households stay perfectly mobile while only a fraction of firms can freely migrate. The share of mobile firms is defined as the ratio of the number of mobile firms m^i_{mob} in region i to the amount of total firms m^i in region i:

$$\alpha^i = \frac{m^i_{mob}}{m^i} = 1 - \frac{m^i_{immob}}{m^i} \tag{27}$$

with m^i_{immob} for the number of immobile firms. Then, assuming $\alpha^1 = \alpha^2$, the total number of mobile firms in the state union is given by

$$\alpha M = \alpha m^1 + \alpha m^2 \tag{28}$$

[10] See appendix, Lemma 6 and Lemma 7.

and the adjusted migration equilibrium reads as

$$U\left(\frac{\pi^1}{\alpha m^1}\right) - U\left(\frac{\pi^2}{\alpha M - \alpha m^1}\right) = 0 \tag{29}$$

implying $\frac{\partial \alpha m^1}{\partial t^1} = \alpha \frac{\partial m^1}{\partial t^1}$. The optimization problem of government i changes to

$$\max_t \ln V = (1-x)\ln U\left(\frac{\pi(\cdot)}{(1-\alpha)m + \alpha m(t)}\right) + x \ln EU(\cdot) \tag{30}$$

The only difference in comparison to equation (24) appears in the denominator of Π in the first term of the equation. The government takes the value of α as given and considers the effect of a contribution rate increase on total profits and the mobile firms. With respect to the first order condition (25), solely the last term adjusts such that

$$\frac{\partial \ln V}{\partial t} = (\cdots) + (1-x)\frac{U_\Pi \Pi_{\alpha m}}{E\Pi}\frac{\partial \alpha m}{\partial t} \stackrel{!}{=} 0 \tag{31}$$

Taking into account the optimality condition of wage negotiations (14) as well as $\frac{\partial \alpha m^1}{\partial t^1} = \alpha \frac{\partial m^1}{\partial t^1}$ and $\Pi_{\alpha m^i} = \Pi_{m^i}$, the first-order condition is modified as follows:

$$\begin{aligned}\frac{\partial \ln V}{\partial t} = {} & E\Pi_w w_t \frac{1-x}{x}\frac{EU}{E\Pi}\left(1 - \frac{1}{2}\alpha\right) \\ & - \left(E\Pi_w w_t \frac{1-g}{g}\frac{EU}{E\Pi} - \frac{l}{n}U_{\tilde{w}}\tilde{w}_t - \frac{n-l}{n}U_b b_t\right)\left(1 - \frac{1}{2}\right) \stackrel{!}{=} 0\end{aligned} \tag{32}$$

If $\alpha = 1$, that is entrepreneurs do not face mobility costs, equation (32) boils down to the first-order condition (25), and the government sets an actuarially fair contribution rate. However, if mobility costs rise, that is α takes lower values than unity, the costs from a rise in the contribution rate become relatively higher. The government sets a lower than fair contribution rate. The intuition for this behavior is given for the case of immobile firms in the following.

Consider $\alpha = 0$. Then, for any given value of $x = g < 1$, the decentral government has an incentive to increase social welfare by setting a lower tax rate than socially optimal: $t < \frac{n-l}{n}$. The reason is that profit per capita Π does not depend on the number of households, which are still fully mobile, but on the number of employed and wages. Furthermore, total profits π increase with lower tax rates (due to $w_t > 0$). With complete immobility of firm owners, the government has now an incentive to levy lower contribution rates, because the social cost of a lower than actuarially fair contribution rate is partially shared with the inhabitants of the other region while the benefits are shared only among firm owners in the own region. Therefore the cost of a tax increase appear to be relatively lower, because the workers, who take the burden of that policy, emigrate from the region with the higher contribution rate to the region with the lower contribution rate: $n_t > 0$.[11] Additionally, the remaining worker inhabitants profit from a higher employment probability, because

[11] See appendix, Lemma 4.

employment increases and the number of union members decreases. As a result the government sets a lower contribution than actuarially fair to maximize social welfare.

Proposition 3. *In a decentralized economy with perfect mobility of households and costs of migration of firms ($\alpha < 1$), if the government uses the bargaining power as weights in the welfare function ($x = g$) it sets a lower than actuarially fair contribution rate such that workers are underinsured against unemployment.*

The following corollary taking account of any degree of mobility of households and firms can be derived in complete analogy to the proposition. By defining $\beta^i = \frac{n^i_{mob}}{n^i}$ as the mobile share of workers and following the adapted reasoning above we obtain:

Corollary *In a decentralized economy with imperfect mobility of households and firms ($\alpha < 1, \beta < 1$) and where the degree of mobility differs between households and firms ($\alpha \neq \beta$), if the government uses the bargaining power as weights in the welfare function ($x = g$) it sets a contribution rate which differs from the actuarially fair contribution rate and over- or underinsurance may occur.*

If the degree of mobility differs between households and firms, the opportunities to evade governmental policies differs, too. Hence, the less mobile group of individuals will be stronger favored by the insurance policy because being a more fix factor in society yields a higher weight in the welfare function. E.g. if households are less mobile than firms ($\beta < \alpha$) the contribution rate chosen by the decentral government will be higher than the actuarially fair one. Because the benefit of households due to higher wages ($w_t > 0$) counts more in the welfare function than the profit loss. Hence, the households will be overinsured.
Now we compare the regime of decentralized governments with a centralized insurance of unemployment. Because the migration externalities are fully internalized in this setting we return w.l.o.g. to the assumption that households and firms are perfectly mobile.

7 Centralized tax and benefit

Instead of considering a unique central government which determines the insurance against unemployment for all workers in both states we model the central insurance as being determined by negotiations between the governments of the states. Taking account of a common insurance budget for both states the governments Nash-bargain about the contribution rate and the implied unemployment benefit. The reason to do this is twofold. First of all, assuming a central government would lead to the same policy as a government in an autarchic economy pursues. Hence, modelling the central regime in this way makes no difference and yields the result that with centralization the unemployment insurance is equivalent to that chosen by decentralized governments

when mobility is perfect. Second, posing the question of centralization with regard to the discussion in the European Union the model of negotiations between states about the central insurance of unemployment is more appropriate. In the European Union, policies concerning all member states are effectively negotiated by the European Council, i.e. the governments of all member states.
In this sense of a centralized unemployment insurance the uniform contribution rate to finance the unemployment benefit is determined in negotiations between both local governments.[12] By assumption both states have the same bargaining power and the outside options are normalized to zero. Nash-bargaining then maximizes the function $V = \left(E\Pi^1\right)^{1-x^1}\left(E\Pi^2\right)^{1-x^2}\left(EU^1\right)^{x^1}\left(EU^2\right)^{x^2}$, or the respective logarithmic transformation

$$\begin{aligned}\max_t \ln V = &(1-x^1)\ln U\left(\frac{f(l^1(w^1(t)))-w^1(t)l^1(w^1(t))}{m^1}\right)\\&+(1-x^2)\ln U\left(\frac{f(l^2(w^2(t)))-w^2(t)l^2(w^2(t))}{m^2}\right)\\&+x^1\ln\left(\frac{l^1(w^1(t))}{n^1(t)}\left[U(\tilde{w}^1(w^1(t),t))-U(b[l^1(w^1(t)),l^2(w^2(t)),w^1(t),w^2(t),t])\right]\right.\\&\left.+U(b[l^1(w^1(t)),l^2(w^2(t)),w^1(t),w^2(t),t])\right)\\&+x^2\ln\left(\frac{l^2(w^2(t))}{N-n^1(t)}\left[U(\tilde{w}^2(w^2(t),t))-U(b[l^1(w^1(t)),l^2(w^2(t)),w^1(t),w^2(t),t])\right]\right.\\&\left.+U(b[l^1(w^1(t)),l^2(w^2(t)),w^1(t),w^2(t),t])\right)\end{aligned} \tag{33}$$

Taking into account the optimality condition of wage negotiations, equation (14) the first order condition reads as

$$\begin{aligned}\frac{\partial \ln V}{\partial t} = &E\Pi^1_{w^1}w^1_t x^1\left(\frac{1-x^1}{x^1}-\frac{1-g^1}{g^1}\right)\frac{EU^1}{E\Pi^1}+x^1\frac{l^1}{n^1}U_{\tilde{w}^1}\tilde{w}^1_t+x^1\frac{n^1-l^1}{n^1}U_b b_t\\&+x^1\frac{n^1-l^1}{n^1}U_b\left[b_{w^2}w^2_t+b_{l^2}l^2_{w^2}w^2_t\right]\\&+E\Pi^2_{w^2}w^2_t x^2\left(\frac{1-x^2}{x^2}-\frac{1-g^2}{g^2}\right)\frac{EU^2}{E\Pi^2}+x^2\frac{l^2}{n^2}U_{\tilde{w}^2}\tilde{w}^2_t+x^2\frac{n^2-l^2}{n^2}U_b b_t\\&+x^2\frac{n^2-l^2}{n^2}U_b\left[b_{w^1}w^1_t+b_{l^1}l^1_{w^1}w^1_t\right]\\&+n^1_t\left(x^1EU^1_{n^1}-x^2EU^2_{n^2}\right)+m^1_t\left((1-x^1)\frac{EU^1}{E\Pi^1}U_{\Pi^1}\Pi^1_{m^1}-(1-x^2)\frac{EU^2}{E\Pi^2}U_{\Pi^2}\Pi^2_{m^2}\right)\stackrel{!}{=}0\end{aligned} \tag{34}$$

[12]Consider for example the Council of the European Union or the European Comission where decisions that concern the interests of the member states or the entire European Union are frequently discussed and negotiated.

With symmetric states $EU^1_{n^1} = EU^2_{n^2}$ and $E\Pi^1_{m^1} = E\Pi^2_{m^2}$ such that

$$\frac{\partial \ln V}{\partial t} = \frac{l}{n} U_{\tilde{w}} \tilde{w}_t + \frac{n-l}{n} U_b b_t + E\Pi_w w_t \left(\frac{1-x}{x} - \frac{1-g}{g} \right) \frac{EU}{E\Pi} + \frac{n-l}{n} U_b \left[b_w + b_l l_w \right] w_t \stackrel{!}{=} 0 \quad (35)$$

In comparison to the social optimum, equation (15), besides the misrepresentation effect an additional term appears in equation (35): $\frac{n-l}{n} U_b \left[b_l l_w + b_w \right] w_t$, which we call the *common budget effect*. This effect is negative, because $-\eta^i_{l,w} - \frac{n^i - l^i}{n^i} > 0$ by assumption,[13] and $w^i_t > 0$, evaluated at the fair contribution rate.[14] Hence, disregarding the misrepresentation effect, the negotiated uniform contribution rate is lower than the actuarially fair one chosen by the social planner.

The emergence of the common budget effect can be explained as follows. The level of the contribution rate t is determined via Nash-bargaining and applies uniformly to both regions due to the common budget. In the negotiations each local government considers the effects that occurred if it set the value for t unilaterally. Thereby the local government, e.g. of region 1, anticipates that an increase in the contribution rate does not only affect the labor market conditions in region 1 but also those of region 2. There, a higher contribution rate increases the wage level ceteris paribus, which adversely affects the level of the uniform unemployment benefit. This in turn means that the unemployed in region 1 are worse off from a rise in the contribution rate. The government of region 1 anticipates additional costs in this bargaining situation. As the same reasoning applies for the government in region 2, both governments favor a lower contribution rate compared to the social planner. Furthermore, as in the decentral case, migrational responses do not distort the setting of the contribution rate. This is due to the assumption of symmetric regions.

Proposition 4. *In a centralized economy with full mobility and negotiations about the uniform contribution rate, if the governments use the bargaining power as weights in the welfare function ($x^i = g^i$) they choose a uniform contribution rate that is lower than the socially optimal contribution rate such that workers are underinsured against unemployment.*

If the condition $-\eta^i_{l,w} - \frac{n^i - l^i}{n^i} < 0$ holds, the common budget effect is of positive sign, and the opposite reasoning applies. Then, the governments do not anticipate additional costs but additional benefits from a higher contribution rate. Therefore, the negotiated level of the unifrom contribution rate is higher than actuarially fair, which implies overinsurance. However, in the centralized economy efficient insurance does only occur, if $-\eta^i_{l,w} = \frac{n^i - l^i}{n^i}$.

[13] The inequality states that the value of the short run labor demand elasticity with respect to the gross wage is larger than the value of the unemployment rate. Hamermesh (1993) summarizes the results of several empirical studies, which estimate the short run labor demand elasticity. Out of 15 studies only one study shows a value of $|\eta_{l,w}| < 0.24$. A more recent study of Lichter, Peichl, and Siegloch (2015) finds a mean value of 0.197 in a meta-regression analysis. According to Eurostat (2017), the countries with the highest unemployment rate in the European Union during the last 10 years were Greece and Spain with single peak rates about 23 per cent. See also appendix, Lemma 9.

[14] See appendix, Lemma 1

8 Conclusion

We develop a simple model of a two-state union, which is characterized by mobility of labor force and firm owners. Due to collective bargaining there is unemployment on the labor market. The governments run a social insurance system to hedge the risk of unemployment. In the paper we compare two different approaches to financing the unemployment benefits: decentral responsibilities about local contribution rates and central negotations about a uniform contribution rate.

First we identify a misrepresentation effect that emerges, if the governments do not use the societal power of workers and firms to weight the groups in their welfare function. Depending on the direction of this bias of representation, it may cause over- or underinsurance. As the misrepresentation effect occurs in the decentral scenario as well as in the central scenario, it does not have an impact on the comparison of both cases.

Second migration effects arise, which emerge in both scenarios. It can be shown that they do not distort the decision of the governments as long as workers as well as firm owners are fully mobile.

Third a common budget effect was identified in the central scenario, which does not appear in the decentral scenario. This budget effect leads to underinsurance of the risk of unemployment, because the local governments overestimate the related costs of a tax increase in their negotiations about a uniform contribution rate.

The results of the model show that the central organization of unemployment insurance is not socially optimal irrespective of the degree of mobility in the state union. The states in a union maintaining their autonomy and negotiating about a common unemployment insurance overestimate the costs of such an insurance and underinsure the labor force against unemployment.

If each member state of the union keeps the competence for its own unemployment insurance the governments choose the social optimal insurance if the labor force and the firms are perfectly mobile in the state union. In this case, the decentral organization is clearly more efficient than the central organization. Although the case of full mobility seems to be an heroic assumption, the EU policy is heading for the goal to reduce impediments of migration more and more. Hence, pursuing this aim and at the same time planning to centralize the unemployment insurance in the EU is not a welfare maximizing policy. However, if the mobility of the societal groups remains constrained and varies among the groups migration externalities arise that are not internalized by the local governments. They distort the decisions away from the socially optimal insurance. In this case it is important how much the degree of mobility differs between the groups. A similar degree of mobility would again induce the local governments to choose the socially optimal insurance. Otherwise, the advantage of decentral organization depends on the size of the not-internalized migration externalities and the common budget effect.

9 Appendix

Lemma 1. *If households are risk averse and the contribution rate is fair, $w_t > 0$.*

Proof. Applying the implicit function theorem on the first order condition of the bargaining problem equation (13) yields the derivative of the gross wage rate with respect to the contribution rate.

$$\frac{dw}{dt} = -\frac{\ln \Psi_{wt}}{\ln \Psi_{ww}} \tag{36}$$

Its sign depends on the numerator, because $\Psi_{ww} < 0$ is assumed to hold for a unique maximum of the Nash product. We show

$$\ln \Psi_{wt} = g\frac{EU_{wt}EU - EU_w EU_t}{EU^2} > 0 \tag{37}$$

Because $EU > 0$ and $g > 0$, equation (37) holds, if $EU_{wt}EU - EU_w EU_t > 0$. For $t^* = \frac{n-l}{n}$, this condition is unambiguously fulfilled for $\sigma > 0$:

$$\begin{aligned}&\left(\frac{l_w}{n}(U_{\tilde{w}}\tilde{w}_t - U_b b_t) + \frac{l}{n}[U_{\tilde{w}\tilde{w}}\tilde{w}_t(1-t) - U_{\tilde{w}}] + (U_{bb}b_t t + U_b)\left[\frac{l}{n} + \frac{wl_w}{n-l}\right]\right)\left(\frac{l}{n}U(\tilde{w}) + \frac{n-l}{n}U(b)\right)\\ &-\left(\frac{l_w}{n}[U(\tilde{w}) - U(b)] + \frac{l}{n}U_{\tilde{w}}(1-t) + U_b t\left[\frac{l}{n} + w\frac{1}{n-l}l_w\right]\right)\left[\frac{l}{n}(U_{\tilde{w}}\tilde{w}_t - U_b b_t) + U_b b_t\right] > 0\end{aligned} \tag{38}$$

$$\begin{aligned}&\frac{l}{n}\left(U_{\tilde{w}}\left(-\frac{U_{\tilde{w}\tilde{w}}}{U_{\tilde{w}}}w(1-t) - 1\right) - \left(-\frac{U_{bb}}{U_b}b - 1\right)U_b\left[1 + \frac{n}{n-l}\eta\right]\right)\left(\frac{l}{n}U(\tilde{w}) + \frac{n-l}{n}U(b)\right)\\ &+\frac{l_w}{n}\left(-U_{\tilde{w}}wU(b) - U_b w\frac{l}{n-l}U(\tilde{w})\right)\\ &-\frac{l}{n}\left(U_{\tilde{w}}(1-t) + U_b t\left[1 + \frac{n}{n-l}\eta\right]\right)\left[\frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t\right] > 0\end{aligned} \tag{39}$$

$$\begin{aligned}&(\sigma - 1)\left(U_{\tilde{w}}\frac{n-l}{n} + U_b\left[-\frac{n-l}{n} - \eta\right]\right)\left(\frac{l}{n}U(\tilde{w}) + \frac{n-l}{n}U(b)\right) - \eta U(b)U_{\tilde{w}}\frac{n-l}{n}\\ &-\eta\frac{l}{n}U(\tilde{w})U_b + \frac{n-l}{n}(U_{\tilde{w}} - U_b)U_{\tilde{w}}\tilde{w}\frac{l}{n} - \frac{n-l}{n}(U_{\tilde{w}} - U_b)U_b b\left[-\frac{n-l}{n} - \eta\right] > 0\end{aligned} \tag{40}$$

Evaluating at $t^* = \frac{n-l}{n}$:

$$-(\sigma - 1)[U_b U(b)\eta] - U(b)U_{\tilde{w}}\eta > 0 \tag{41}$$

$$\sigma > 0 \tag{42}$$

■

Lemma 2. *Right-to-manage bargaining implies a lower wage level than the wage level set by the social planner.*

Proof. Rewriting the first order condition (13) of the Nash-bargaining and evaluating at the fair contribution rate, $t^* = \frac{n-l}{n}$ yields

$$g\frac{\frac{l_w}{n}(U(\tilde{w})-U(b))+\frac{l}{n}U_{\tilde{w}}(1-t^*)+\frac{n-l}{n}U_b(t^*w\frac{n}{(n-l)^2}l_w+t^*\frac{l}{n-l})}{EU}=(1-g)\frac{U_\Pi\frac{1}{m}l}{E\Pi} \tag{43}$$

$$g\frac{\frac{l}{n}U_b(1-t^*)+U_b(t^*w\frac{1}{n-l}l_w+t^*\frac{l}{n})}{EU}=(1-g)\frac{U_\Pi\frac{1}{m}l}{E\Pi} \tag{44}$$

$$g\frac{\left(\frac{l}{n}(1-t^*)+t^*w\frac{1}{n-l}l_w+t^*\frac{l}{n}\right)U_b}{EU}=(1-g)\frac{U_\Pi\frac{1}{m}l}{E\Pi} \tag{45}$$

$$g\frac{\left(1+t^*\frac{n}{n-l}\eta_{l,w}\right)\frac{l}{n}U_b}{EU}=(1-g)\frac{U_\Pi\frac{1}{m}l}{E\Pi} \tag{46}$$

$$g\left(1+\eta_{l,w}\right)\frac{U_b}{EU}\frac{1}{n}=(1-g)\frac{U_\Pi}{E\Pi}\frac{1}{m} \tag{47}$$

For the reasonable assumption $-1 < \eta_{l,w} < 0$ and $g = x$, the left hand side is smaller than the equivalent expression in the first order condition of the social planer (compare condition (19)). This means that the costs associated with a wage increase are relatively higher in the case of right-to-manage bargaining. The social planner sets a higher wage compared to the wage negotiated on an imperfect labor market. ∎

Lemma 3. *A higher wage rate decreases the expected utility of entrepreneurs.*

Proof. The derivative of $E\Pi = U(\Pi) = U\left(\frac{\pi}{m}\right)$ with respect to the wage rate is given by

$$E\Pi_w = U_\Pi \Pi_\pi \left(\pi_f f_l l_w + \pi_w + \pi_l l_w\right) \tag{48}$$

$$= U_\Pi \Pi_\pi \left(\pi_f l_w (f_l + \pi_l) + \pi_w\right) \tag{49}$$

$$= -\frac{l}{m}U_\Pi < 0 \tag{50}$$

∎

Lemma 4. *For decentralized regions, $n^1_{t_1} \geq 0$, evaluated at $t^* = \frac{n^1-l^1}{n^1}$.*

Proof. The migration equilibrium is given by

$$\begin{aligned} EU^1 - EU^2 &= 0 \\ \frac{l^1\left(w^1\left(t^1\right)\right)}{n^1} U\left(\tilde{w}^1\left(t^1, w^1\left(t^1\right)\right)\right) & \\ + \frac{n^1 - l^1\left(w^1\left(t^1\right)\right)}{n^1} U\left(b^1\left(n^1, t^1, w^1\left(t^1\right), l^1\left(w^1\left(t^1\right)\right)\right)\right) & \\ - \frac{l^2\left(w^2\left(t^2\right)\right)}{N-n^1} U\left(\tilde{w}^2\left(t^2, w^2\left(t^2\right)\right)\right) & \\ - \frac{N-n^1-l^2\left(w^2\left(t^2\right)\right)}{N-n^1} U\left(b^2\left(N-n^1, t^2, w^2\left(t^2\right), l^2\left(w^2\left(t^2\right)\right)\right)\right) &= 0 \end{aligned} \tag{51}$$

Deriving equation (51) implicitly with respect to n^1 and t^1 yields

$$\frac{dn_1}{dt_1} = -\frac{EU^1_{t^1} - EU^2_{t^1}}{EU^1_{n^1} - EU^2_{n^1}} = -\frac{F_{t^1}}{F_{n^1}} \tag{52}$$

with

$$\begin{aligned} F_{n^1} = &-\frac{l^1}{(n^1)^2}\left(U(\tilde{w}^1) - U(b^1)\right) - \frac{l^1}{n^1} U_{b^1} \frac{w^1 t^1}{n^1 - l^1} \\ &- \frac{l^2}{(N-n^1)^2}(U(\tilde{w}^2) - U(b^2)) - \frac{l^2}{N-n^1} U_{b^2} \frac{w^2 t^2}{N-n^1-l^2} < 0 \end{aligned} \tag{53}$$

and

$$\begin{aligned} F_{t^1} = &\frac{l^1_{w^1} w^1_{t^1}}{n^1}\left[U(\tilde{w}^1) - U(b^1)\right] + \frac{l^1}{n^1} U_{\tilde{w}^1} \tilde{w}^1_{t^1} + \frac{l^1}{n^1} U_{\tilde{w}^1} \tilde{w}^1_{w^1} w^1_{t^1} + \frac{n^1 - l^1}{n^1} U_{b^1}\left[b^1_{w^1} w^1_{t^1} + b^1_{l^1} l^1_{w^1} w^1_{t^1} + b^1_{t^1}\right] \\ = &w^1_{t^1}\left(\frac{l^1_{w^1}}{n^1}\left[U(\tilde{w}^1) - U(b^1)\right] + \frac{l^1}{n^1} U_{\tilde{w}^1} \tilde{w}^1_{w^1} + \frac{n^1 - l^1}{n^1} U_{b^1}\left[b^1_{w^1} + b^1_{l^1} l^1_{w^1}\right]\right) \\ &+ \frac{l^1}{n^1} U_{\tilde{w}^1} \tilde{w}^1_{t^1} + \frac{n^1 - l^1}{n^1} U_{b^1} b^1_{t^1} \end{aligned} \tag{54}$$

such that

$$n^1_{t^1} = -\frac{EU^1_{w^1} w^1_{t^1}}{F_{n^1}} \geq 0 \tag{55}$$

for $t^* = \frac{n^1-l^1}{n^1}$. Equality holds for $g^1 = 1$, because then $EU^1_{w^1} = 0$. ■

Lemma 5. *For decentralized regions, $m^1_{t_1} \geq 0$, evaluated at $t^* = \frac{n^1 - l^1}{n^1}$.*

Proof. The migration equilibrium implies

$$\frac{dm^1}{dt^1} = -\frac{E\Pi^1_{w^1} w^1_{t^1}}{E\Pi^1_{m_1} - E\Pi^2_{m_1}} \tag{56}$$

where $E\Pi^1_{m^1} < 0$, $E\Pi^2_{m^1} > 0$, $E\Pi^1_{w^1} < 0$ and $w^1_{t^1} > 0$. Therefore, $\frac{dm^1}{dt^2} < 0$. ■

Lemma 6. *For decentralized symmetric regions, $EU^i_{n^i} n^i_{t^i} = -\frac{1}{2}(EU^i_{w^i} w^i_{t^i} + EU^i_{t^i})$ holds for each region.*

Proof. The migration equilibrium is given by

$$\begin{aligned}
EU^1 - EU^2 = 0 \\
\frac{l^1\left(w^1\left(t^1\right)\right)}{n^1} U\left(\tilde{w}^1\left(t^1, w^1\left(t^1\right)\right)\right) \\
+\frac{n^1 - l^1\left(w^1\left(t^1\right)\right)}{n^1} U\left(b^1\left(n^1, t^1, w^1\left(t^1\right), l^1\left(w^1\left(t^1\right)\right)\right)\right) \\
-\frac{l^2\left(w^2\left(t^2\right)\right)}{N - n^1} U\left(\tilde{w}^2\left(t^2, w^2\left(t^2\right)\right)\right) \\
-\frac{N - n^1 - l^2\left(w^2\left(t^2\right)\right)}{N - n^1} U\left(b^2\left(N - n^1, t^2, w^2\left(t^2\right), l^2\left(w^2\left(t^2\right)\right)\right)\right) = 0
\end{aligned} \tag{57}$$

Deriving equation (57) implicitly with respect to n^1 and t^1 yields

$$\frac{dn_1}{dt_1} = -\frac{EU^1_{w^1} w^1_{t^1} + EU^1_{t^1}}{EU^1_{n_1} - EU^2_{n_1}} \tag{58}$$

The denominator is given by

$$\begin{aligned}
EU^1_{n_1} - EU^2_{n_1} = & -\frac{l_1}{n_1^2} U(\tilde{w}_1) + \frac{n_1 - n_1 + l_1}{n_1^2} U(b_1) + \frac{n_1 - l_1}{n_1} U_{b_1} b^1_{n^1} \\
& - \left(\frac{-l_2(-1)}{(N - n_1)^2}\right) U(\tilde{w}_2) - \frac{-1(N - n_1) - (N - n_1 - l_2)(-1)}{(N - n1)^2} U(b_2) \\
& - \frac{N - n_1 - l_2}{N - n_1} U_{b_2} b^2_{n^1}
\end{aligned} \tag{59}$$

$$\begin{aligned}
= & -\frac{l_1}{n_1^2}(U(\tilde{w}_1) - U(b_1)) - \frac{n_1 - l_1}{n_1} U_{b_1} \frac{l_1 w_1 t_1}{(n_1 - l_1)^2} \\
& - \frac{l_2}{(n^2)^2}(U(\tilde{w}_2) - U(b_2)) - \frac{n^2 - l_2}{n^2} U_{b_2} \frac{l_2 w_2 t_2}{(n^2 - l_2)^2}
\end{aligned} \tag{60}$$

$$= EU^1_{n^1} + EU^2_{n^2} \tag{61}$$

If regions are symmetric with $l^1 = l^2$, $\tilde{w}^1 = \tilde{w}^2$, $w^1 = w^2$, $b^1 = b^2$, $t^1 = t^2$, $n^1 = n^2$, equation (58) becomes

$$\frac{dn^i}{dt^i} = -\frac{EU^i_{w^i} w^i_{t^i} + EU^i_{t^i}}{2EU^i_{n^i}} \tag{62}$$

■

Lemma 7. *For decentralized symmetric regions, $E\Pi^i_{m^i} m^i_{t^i} = -\frac{1}{2} E\Pi^i_{w^i} w^i_{t^i}$ holds for each region.*

Proof. The migration equilibrium is given by

$$E\Pi^1 - E\Pi^2 = 0 \tag{63}$$

$$U\left(\frac{f(l^1(w^1(t^1))) - w^1(t^1)l^1(w^1(t^1))}{m^1(t^1)}\right) - U\left(\frac{f(l^2(w^2(t^2))) - w^2(t^2)l^2(w^2(t^2))}{M - m^1(t^1)}\right) = 0 \tag{64}$$

Deriving equation (64) implicitly with respect to m^1 and t^1 yields

$$\frac{dm_1}{dt_1} = -\frac{E\Pi^1_{w^1} w^1_{t^1}}{E\Pi^1_{m_1} - E\Pi^2_{m_1}} \tag{65}$$

The denominator is given by

$$E\Pi^1_{m^1} - E\Pi^2_{m^1} = U_{\Pi^1}\Pi^1_{m^1} - U_{\Pi^2}\Pi^2_{m^1} \tag{66}$$

$$= U_{\Pi^1}\left(-\frac{\pi^1}{(m^1)^2}\right) - U_{\Pi^2}\frac{-\pi^2(-1)}{(M - m^1)^2} \tag{67}$$

$$= E\Pi^1_{m^1} + E\Pi^2_{m^2} \tag{68}$$

If regions are symmetric with $\pi^1 = \pi^2$ and $m^1 = m^2$, equation (65) becomes

$$\frac{dm^i}{dt^i} = -\frac{E\Pi^i_{w^i} w^i_{t^i}}{2E\Pi_{m^i}} \tag{69}$$

■

Lemma 8. *For decentralized symmetric regions with full mobility of workers and firm owners, the migrational effects do not distort the setting of the contribution rate.*

Proof. Multiplying equation (25) by $\frac{EU}{x}$, and rewriting the migrational effects (ME), yields

$$ME = -\left(\frac{l}{n^2}[U(\tilde{w}) - U(b)] - \frac{n-l}{n}U_b b_n\right) n_t + \frac{1-x}{x}\frac{EU}{E\Pi}U_\Pi \Pi_m m_t \tag{70}$$

$$ME = -EU_n \frac{EU_w w_t + EU_t}{2EU_n} - \frac{1-x}{x}\frac{EU}{E\Pi}E\Pi_m \frac{E\Pi_w w_t}{2E\Pi_m} \tag{71}$$

$$ME = -\frac{1}{2}\left(EU_w w_t + EU_t + \frac{1-x}{x}\frac{EU}{E\Pi}E\Pi_w w_t\right) \tag{72}$$

$$ME = -\frac{1}{2}\left(E\Pi_w w_t \left(\frac{1-x}{x} - \frac{1-g}{g}\right)\frac{EU}{E\Pi} + \frac{l}{n}U_{\tilde{w}}\tilde{w}_t + \frac{n-l}{n}U_b b_t\right) \tag{73}$$

which in comparison to condition (26) show that each effect of a tax increase is affected uniformly by the migration responses. ■

Lemma 9. *For $w_t > 0$, the direction of the common budget effect depends on the labor demand elasticity and the unemployment rate.*

Proof. The common budget effect may be rewritten as follows

$$0 > \frac{n-l}{n}U_b[b_l l_w + b_w]w_t \tag{74}$$

$$0 > wl_w \frac{n}{n-l} + l \tag{75}$$

$$0 > \eta_{l,w} + \frac{n-l}{n} \tag{76}$$

■

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