TEMPORARY SHOCKS AND THE UNAVOIDABLE ROAD TO HIGH TAXES AND HIGH UNEMPLOYMENT

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Abstract

This paper considers a model with endogenous job destruction in which the effect of tax rates on employment can be large even if the elasticity of substitution between consumption and leisure is low. Necessary is only that the mass of marginal jobs is large. Moreover, tax-financed unemployment benefits generate an externality that leads to multiple (stable) steady states. Uniqueness of equilibrium is analysed in an example in which there is a low-unemployment low-tax steady state and a high-unemployment high-tax steady state. After a large increase in the unemployment rate, the economy can only converge towards the high-unemployment steady state, which offers an explanation to why European unemployment rates remained high after they increased during the seventies. The equilibrium time path is not always unique. Moreover, the range of unemployment levels at which self-fulfilling expectations can reduce unemployment rates typically increases when the government is allowed to borrow. A balanced-budget fiscal policy, however, is to be preferred if the expected increase in productivity for new ventures is high.

Key Words: Multiple Equilibria, Self-fulfilling expectations, Job Search, Unemployment Benefits, Fiscal Policy.

JEL Classification: D50, C62, E24, E62, J64.

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1 Introduction

In many European countries and in the U.S., unemployment rates increased sharply during the seventies. In the U.S., unemployment rates returned to levels observed before the seventies fairly quickly and in 2000 even reached levels below 4%. In several European countries unemployment rates have also recovered substantially, although not as quickly. In some European countries, however, unemployment rates have remained high. This is documented in Figure 1 that plots the US unemployment rate together with the combined unemployment rate for France, Germany, and Italy. These three countries are not the largest economies on the continent. Moreover, these countries have experienced the most persistent high unemployment rates.[1]

Recently, several articles have argued that an important reason for the high European unemployment rates is the interaction between employment-unfriendly institutions, such as generous unemployment benefits, and a deterioration in economic conditions.[2] Blanchard and Wolfers (2000) provide empirical evidence of the importance of this interaction between institutions and economic conditions for the behavior of unemployment rates.

One important employment-unfriendly factor is the tax burden on market production. As documented in Figure 2, European government outlays as a percentage of GDP accelerated in the seventies especially relative to the US counterpart. It is, therefore, not astonishing that , the effect of tax rates on employment has received a lot of attention in both the empirical and the theoretical literature. Moreover, several papers have found empirical evidence that tax rates are helpful in explaining the behavior of European unemployment rates, although the results differ strongly in terms of quantitative importance.[3] The behavior of unemployment rates is complex. To accurately explain differences across countries and changes over time, it is, therefore, important to take into account multiple factors. In this paper, we look at the relation between taxes and unemployment from a novel theoretical angle. To make the analysis as clear as possible, we abstract from other possible factors.[4]

[1] Recent unemployment rates are even higher in Spain. It is excluded because of the extraordinary swings in the unemployment rate: The Spanish unemployment rate increased from 1.5% in 1970 to its maximum value of 24% in 1994 and then decreased to 11% in 2003.

[2] For example, Ljungqvist and Sargent (1998) argue that the probability of skill loss after displacement has increased; Daveri and Tabellini (2000) argue that the wedge between taxes on income and benefits has increased; and Mortensen and Pissarides (1999) argue that the variance of idiosyncratic productivity shock has increased.

[3] See Disney (2000) and Nickell (2004) for an overview of the empirical estimates.

[4] Nunziata (2002) found that in addition to variations in the tax wedge, other institutional variables such as benefit variables, union density, coordination in wage bargaining, and contract regulations affect unemployment. He also found the terms of trade and TFP to be significant.

Standard theoretical models that study the effect of tax rates on employment focus on the number of hours worked. In these models, an increase in the tax rate has two opposite effects on hours worked: it makes leisure relatively cheaper, which increases hours worked (substitution effect), and it decreases the budget set, which pushes hours worked in the opposite direction (income effect). The total effect depends on the elasticity of substitution between consumption and leisure, and for most workers this elasticity is believed to be small.

In this paper, we not only take a fresh look at the effect of tax rates on unemployment, but also consider a model in which tax rates are endogenous.[5] The model is a simple search model in which tax rates, idiosyncratic productivity levels, and expectations about the future determine whether it is worthwhile for agents to be engaged in market production, that is, to be not unemployed. With this framework we make the following contributions to the literature.

- We consider the effect of tax rates on employment in a model that allows for the endogenous destruction of jobs, that is, we focus on the extensive margin. In this type of model the quantitative effect of tax rates on employment is not determined by the elasticity of substitution in the agent's utility function, but by the cross-sectional distribution of the surplus values of the jobs in the economy. The paper shows that small changes in the tax rates could have huge effects if the mass of marginal jobs is large. This is a relatively staightforward result, but it is very important. Note that the mass of marginal jobs is affected by many variables including labor market institutions, industry composition, and education levels. The mass of marginal jobs will, thus, most likely vary across countries and time. Empirical studies that do not control for these differences in the cross-sectional distribution are, therefore, likely to lead to misleading estimates of the effect of tax rates on employment. Moreover, the effect of tax rates on employment be linear only under particular distributional assumptions, which, again, is important for empirical analysis.

- In our framework with endogenous tax rates, agents' decision to continue working or not affect tax rates. Consequently, tax rates constitute an externality. Because of the quantitative importance of tax rates for the job destruction decision, this externality is quantitatively important. We show that this externality can result in multiple steady states. Although any number of steady states is possible, we focus in the calibration on a model in which there are

[5] In several important papers that study the effect of tax rates on employment, such as the recent paper by Daveri and Tabellini (2000), the tax rate is exogenous. It would be possible to use the framework developed here to study exogenous changes in the tax rate, but the analysis becomes much richer when the unemployment rate and the tax rate are determined jointly.

two steady states. The first steady state is characterized by low unemployment and low tax rates and the second by high unemployment and high tax rates. We show that there are parameter values such that both steady states are stable. The idea would be that Europe was in the low unemployment steady state before the seventies and several European countries remained stuck in the high-unemployment steady state after the seventies.

- An important element of this paper is the analysis of the dynamics of the model. The search friction and (in the modified model) the upgrade possibility make this a truly dynamic model in which the number of unemployed is the key state variable. In a dynamic model it is possible that the equilibrium time path is unique even though there are multiple steady states. If the equilibrium is unique, then history—as summarized by the state variables—determines to which steady state the economy will converge. Using the version of the model with two steady states we show the following. If the unemployment rate is close enough to the value of the unemployment rate in the low-unemployment steady state, then the economy will converge towards the low-unemployment steady state. If the unemployment rate is close enough to the value of the high-unemployment steady state, then the economy will converge towards the high unemployment steady state. For intermediate values, history does not determine the equilibrium time path and self-fulfilling expectations become possible.

- This last-mentioned result provides an explanation for the high European unemployment rates, that differs significantly from the type of reason given in the recent literature. Models in the recent literature generate an increase in the unemployment rate by changing a structural parameter in the model. In this paper, the transition to the high-unemployment regime is the unavoidable response to a *one-time* shock. The intuition is as follows. Suppose the private sector is optimistic and expects the economy to move towards the low-unemployment steady state. Although the economy is expected to move back towards low unemployment rates, the search friction still implies that unemployment rates are temporarly higher. Consequently, unemployment benefits are higher and the government has to finance these. If this leads to a tax burden that is too high, then this time path would not be an equilibrium. In this explanation for the high European unemployment rates, the severe economic downturn of the seventies plays a key role. This line of reasoning is similar in spirit to the earlier view on why European unemployment rates are high, which is summarized by Lindbeck (1996) as follows *"... once high unemployment has emerged, basic structures and mechanisms in West European societies tend to*

perpetuate it."

- The paper shows that the type of fiscal policy matters for the question whether economies with high unemployment rates can converge towards the low-unemployment steady state. In particular, we compare a balanced-budget fiscal policy with a balanced-NPV fiscal policy that allows governments to borrow. In the benchmark model, a balanced-NPV fiscal policy makes self-fulfilling expectations more likely and, thus, makes it more likely that economies with high unemployment rates will move towards the low-unemployment steady state. The reader may remember that in the classic paper of Schmitt-Grohé and Uribe (1997) a balanced-NPV fiscal policy makes self-fulfilling expectations *less* likely. The difference come from the fact that our model has multiple steady states, whereas Schmitt-Grohé and Uribe (1997) consider sun spots around a single steady state. The policy recommendations are still the same, since in our framework self-fulfilling epectations are actually desirable if the economy is in the high-unemployment steady state. We consider one important exception. That is, we show that a balanced-budget fiscal policy would be preferred, if the taxable income of new jobs is very low. In such an environment, it is better to have higher tax rates now and lower tax rates later.

The paper is organized as follows. In Section 2, we describe the model. In Section 3, we discuss the properties of the steady states and in particular address the question whether they are unique continuation equilibria. In Section 4, we consider the dynamics of the system after a one-time shock. In these first sections, we consider a model in which the distribution of productivity levels is highly concentrated. In Section 5, we examine distributions of productivity levels that are more spread out. We show that through a domino effect changes in the tax rate can still lead to a large increase in unemployment. In Section 6, we discuss the differences between the balanced-budget and the balanced-NPV fiscal policy. In Section 7, we discuss under what conditions the quantitative effects of tax rates on employment are large. In Section 8, we show that the model is also consistent with the behavior of employment rates and in particular with the increases in tax rates observed before the seventies. The last section concludes.

2 Model

The model used in this paper is a search model that allows for endogenous destruction as in Mortensen and Pissarides (1994). In this section, we develop a very simple and stylized model but its simplicity helps to describe the main ideas of the paper.

For example, in this section we only consider balanced government budgets. This and other simplifying assumption will be relaxed later in the paper.

In Section 2.1, we describe market production. In Section 2.2, we describe the possibilities for those that do not engage in market production. In Section 2.3, we define the surplus of market activities and the condition that determines which jobs are viable. In Section 2.4, we model fiscal policy, and in Section 2.5 we present equilibrium conditions.

2.1 Market production

In this economy there are low-productivity workers and high-productivity workers. To simplify the model the skill level of a worker is given at birth and fixed throughout the worker's life. A high-skilled worker produces z_h and a low-skilled worker produces $z_l < z_h$. Market income is taxed at rate τ. There is a unit mass of workers and the fraction of workers with productivity level k is given by $\phi_k, k \in \{l, h\}$, with $\phi_l + \phi_h = 1$.

A job may experience an *exogenous separation* that occurs with probability ρ_l^x for low-skilled workers and with probability ρ_h^x for high-skilled workers. Exogenous separations reflect events that permanently destroy the productivity of a job, e.g., market conditions may shift adversely. We assume that exogenous separations cannot occur in the period that a job is newly formed. At the beginning of each period the worker decides whether to continue in his current job. If the worker discontinues his job, he enters the unemployment pool where he searches for a new job. Workers are also subject to shocks that induce retirement, occurring at the end of a period. Let ρ^r denote the probability of retirement. A retiring agent leaves the labor market and obtains a future value of zero.

2.2 Possibilities outside the market sector

If a worker is not engaged in market production, he receives an unemployment benefit r and an additional benefit b. The additional benefit can either be interpreted as the benefit of leisure or as home production. We allow for the possibility that unemployment benefits are taxed at rate $\tau_r < \tau$, but assume that the additional benefit b is not taxed. Each period, a proportion ρ^r of the workers leaves the labor force through retirement, replaced by an identical number of new entrants that flow into the unemployment pool.[6] Other workers in the unemployment pool are those that exogenously lost their job or chose to discontinue it. Unemployed

[6] A fraction ϕ of all new borns have low-productivity skills so that the distribution of skill levels across workers does not change.

workers cannot instantaneously start working again. Instead, we assume that they are offered a new job (at their skill level) only with probability λ_k, $k \in \{l, h\}$.

Note that this model can be interpreted as a matching model in which market production takes place in relationships between a worker and an entrepreneur. The difference with standard matching models is that in our model the matching probabilities, λ_l and λ_h, are constant. In our setup, the worker does not have to share the surplus with an employer. Note that in a matching framework with constant matching probabilities, the results would not be affected by the choice of bargaining or the bargaining weight.

2.3 Surplus level

The surplus of a job can be written as

$$s_{k,t} = (1 - \tau_t)\, z_k + g_{k,t} - b - (1 - \tau_{r,t})r - w_{k,t}, \quad k \in \{l, h\}. \tag{1}$$

Here τ_t is the tax rate in period t on market income and $\tau_{r,t}$ is the tax rate on unemployment benefits, $g_{k,t}$ denotes the period t value of future benefits from continuing the job for a worker with skill level k, and $w_{k,t}$ denotes the period t value for a worker with skill level k of the future benefits when he leaves the current period being unemployed. The variables $s_{k,t}$, τ_t, $\tau_{r,t}$, $g_{k,t}$, and $w_{k,t}$ are indexed by t to indicate their dependence on the current and expected future distribution of agents over the different employment and unemployment categories.[7] Workers will choose to continue in their job if and only if $s_{k,t} \geq 0$. Clearly, the *after-tax* value of z_k plays a key role in determining the value of the surplus. Note that tax rates not only affect the current-period benefits of market production, but also the continuation value, $g_{k,t}$.

2.4 Fiscal policy

Throughout the paper we assume that the tax rate on unemployment benefits, $\tau_{r,t}$, is equal to $\psi\tau_t$, so that each period we only have to determine one tax rate. Table 1 reports effective tax rates for labor income and unemployment benefits. For European countries the average value of ψ is roughly 0.4 and this value is used in the calibration. In this section, we assume that the government's budget is balanced period by period and the government, thus, has to use current tax revenues to finance unemployment benefits. In particular, tax rates are solved from

$$\tau_t \left[z_l e_{l,t} + z_h e_{h,t}\right] = gov + (1 - \psi\tau_t) \left[ru_{l,t} + ru_{h,t}\right], \tag{2}$$

[7] To be precise, these variables only depend on current and future tax rates, but indirectly depend on characteristics of the cross-sectional distribution because tax rates do.

where *gov* is the level of per capita government expenditures which is assumed fixed, $e_{k,t}$ denotes the mass of employed workers with productivity level k in period t, and $u_{k,t}$ denotes the mass of unemployed workers with skill level k. We will refer to this policy as the *balanced-budget* fiscal policy. Later in the paper we will consider a fiscal policy under which the government is allowed to borrow. We assume that the government is passive and simply takes the current unemployment rate as given when it sets tax rates. The case where the government takes a more active role is considered in Section 6 where we consider alternative fiscal policies.

2.5 Equilibrium

In this section we discuss equilibrium values for $g_{l,t}$, $g_{h,t}$, $w_{l,t}$, $w_{h,t}$, and laws of motion for the employment and unemployment rate for the different skill levels. The value from continuing a job for a worker with productivity level k is equal to

$$\begin{aligned} g_{k,t} &= \beta(1-\rho^r)\left[\begin{array}{c}(1-\rho^x)\max\{s_{k,t+1},0\}\\ +b+(1-\psi\tau_{t+1})r+w_{k,t+1}\end{array}\right] \\ \text{for } k &\in \{l,h\}. \end{aligned} \tag{3}$$

Similarly, the continuation value for a worker with productivity level k that leaves the current period in the matching market is equal to

$$\begin{aligned} w_{k,t} &= \beta(1-\rho^r)\left[\begin{array}{c}\lambda_k\max\{s_{k,t+1},0\}\\ +b+(1-\psi\tau_{t+1})r+w_{k,t+1}\end{array}\right] \\ \text{for } k &\in \{l,h\}. \end{aligned} \tag{4}$$

The following equations give the laws of motion for $u_{l,t}$, $u_{h,t}$, $e_{l,t}$, and $e_{h,t}$. The variable $I_{k,t}$ is an indicator variable that takes on a value 1 if the worker with skill level k prefers to continue market production and 0 otherwise.

$$\begin{array}{c} u_{k,t} = u_{k,t-1} \\ +\phi_k\rho^r+(1-\rho^r)\rho^x e_{k,t-1}+(1-\rho^r)(1-\rho^x)(1-I_{k,t})e_{k,t-1} \\ -\left[\rho^r+(1-\rho^r)\lambda_k I_{k,t}\right]u_{k,t-1} \\ \text{for } \ k\in\{l,h\}, \end{array} \tag{5}$$

and

$$\begin{array}{c} e_{k,t} = e_{k,t-1} \\ -[\rho^r+(1-\rho^r)\rho^x+(1-\rho^r)(1-\rho^x)(1-I_{k,t})]e_{k,t-1} \\ +(1-\rho^r)\lambda_k I_{k,t}u_{k,t-1} \\ \text{for } k\in\{l,h\}. \end{array} \tag{6}$$

An equilibrium is a set of values for $I_{k,t}$ such that (i) unemployment and employment levels, $u_{k,t}$ and $e_{k,t}$, are determined by (5) and (6), (ii) tax rates, τ_t, are determined by (2), (iii) continuation values, $g_{k,t}$ and $w_{k,t}$, are solved from (3) and (4), and (iv) the sign of the surplus defined in 1 is consistent with the value of $I_{k,t}$. That is, when $I_{k,t} = 0$ then $s_{k,t} \leq 0$ and when $I_{k,t} = 1$ then $s_{k,t} \geq 0$.

3 Steady states

In this section, we discuss the properties of the steady states of the model. In this model there are several candidates that could be steady state solutions and the first subsection discusses this in more detail. In this paper, we consider parameter values such that both a low-unemployment and a high-unemployment steady state exist and these parameter values are given in the second subsection. In the third subsection, we document the properties of the low and the high-unemployment steady state. This section also documents that the values several key variables take on in the low-unemployment and high-unemployment steady state compare well in magnitude to their empirical counterpart observed in Europe when we compare the period before the seventies to the low-unemployment regime and the period after the seventies to the high-unemployment regime. In the fourth subsection, we show that despite the fact that tax rates are quantitatively important, the economy as a whole does not operate on the downward sloping part of the Laffer curve. Finally, the last two subsections analyze whether self-fulfilling expectations are possible. If so then the economy will move out of a particular steady state simply because the agents in the economy believe it will.

When we compare properties of the model with observed quantities, we will focus mainly on France, Germany, and Italy, which are not only the three biggest economies in continental Europe but are often considered as typical for the problems facing European labor markets. We would like to highlight the fact that this is a very stylized model and that there are many important characteristics that are crucial for employment and taxes that are not considered here, such as employment protection, unions, and political economy considerations. The empirical comparison is mainly undertaken to give the reader an idea of the orders of magnitude and what characteristics of the model are essential to generate large movements in unemployment rates.

3.1 Steady states with different unemployment rates

As long as either *gov* or r are positive and z_h not unreasonably large, a "total collapse" steady state would exist, in which neither the low-skilled nor the high-skilled workers are willing to work. In this case the tax base would be equal to zero and the tax rate needed to finance government expenditures would exceed 100%, which would clearly be sufficient to keep the whole economy unemployed. As this is, obviously, not an interesting case, the total collapse steady state will not be considered in this paper. Thus, in all cases considered we have $I_{h,t} = 1$ for all t. Two other, more interesting, steady states are the following. In the first steady state, $I_{l,t} = 1$ for all t, that is, workers with low productivity levels prefer market production over the non-market alternative. In this steady state, only the newly born and those that have experienced an exogenous separation are unemployed. In the second steady state, $I_{l,t} = 0$ (and $I_{h,t} = 1$) for all t, resulting in all workers with low productivity levels being unemployed (in addition to the workers with high skills that have either experienced an exogenous breakup or are newly born). It is easy to find parameter values such that both steady state solutions exist.

The intuition for the existence of multiple steady states is straightforward. When the unemployment rate is high, the tax base is low while the amount of unemployment benefits the government has to pay out is high. Consequently tax rates are high resulting in a low surplus, which means that indeed more workers decide not to participate in market activity. Analogous, there is a steady state with a low unemployment rate.[8]

The idea that taxes work as an externality and may cause the model to have multiple steady state solutions is not new. In fact, Blanchard and Summers (1987) have already argued that increasing returns due to the presence of a large public sector may well be, for macroeconomics, the most important type of increasing returns and be important in understanding the high unemployment rates in Europe. Both the analysis and the focus of this paper, however, is very different from Blanchard and Summers (1987). Most importantly, the focus of the current paper is on dynamics and addresses the question what factors determine the steady state towards which the economy will converge.

Blanchard and Summers (1987) develop a model in which a representative worker who decides how many hours to work. Because of the tax externality the after-tax wage rate is not simply decreasing in employment (as predicted by decreasing returns

[8] We do not consider the knife-edge steady state in which a *fraction* of the low-skilled workers is unemployed and the surplus of the low-skilled is exactly equal to zero. Note that when the surplus is equal to zero workers are indifferent between market and non-market activities and workers of the same skill level could make different choices.

to scale), but is hump shaped. To solve for employment Blanchard and Summers (1987) fix the after-tax wage rate which gives them a stable low-unemployment steady state and an unstable high-unemployment steady state. Our model is more complete, e.g. we do not rely on fixed wages to solve for employment, but also is quite different in its properties. In particular, because of the matching friction it is possible to have outcomes in which the high-unemployment steady state is also stable.[9] Moreover, in the representative agent framework of Blanchard and Summers (1987) the combination of the tax externality and diminishing returns naturally leads to two steady states. We will see below that by relaxing the assumption that the distribution of productivity levels is bimodal, the current setup can easily generate a higher number of steady states.

For a high-unemployment steady state to exist, it is important that the employed are affected more by increases in the tax rate than the unemployed. For example, suppose that there is no utility of leisure and no home production, that is, $b = 0$. In addition assume that unemployments benefits are taxed at the same rate as market income, that is, $\tau_r = \tau$. In this case an increase in tax rates affects both employed and unemployed workers in exactly the same way and the high-tax high-unemployment steady state does not exist. In models that do not allow for endogenous destruction, Pissarides (1998) finds a similar result. That is, he finds that in several models of employment the effect of tax rates on the unemployment rate crucially depends on whether unemployment benefits are indexed to wages. So, we set $b > 0$ and $\tau_r = 0.4\tau < \tau$.

3.2 Parameter values

The benchmark parameter values are given in the first column of Table 2. In Section 7, we will argue that the key piece of information to evaluate the quantitative importance of the mechanisms proposed in this paper is the distribution of the surplus across workers, which is, of course, heavily affected by the distribution of productivity levels. Clearly the distribution of z assumed here is very stylistic and is mainly chosen to illustrate the ideas of the paper. To understand the role of the distribution better we will modify the model and discuss several alternatives. In particular, in Section 3.6 we will make the productivity of the low-skilled workers stochastic. In Section 5, we consider the case in which the mass of the distribution is not concentrated at a few discrete points and allow the distribution of z to have a large number of different realizations.

The role of several parameters will be highlighted when we discuss the results,

[9] A steady state is "stable" if it is a unique continuation equilibrium. This concept will be discussed in more detail in section 3.5.

but it is useful to keep the following in mind. In contrast to several other search and matching models, we assume that becoming unemployed does not help in improving the worker's productivity. Although this seems a reasonable assumption,[10] it leads to endogenous separation only occurring when the benefits of being unemployment are relatively large. In our benchmark parameter set, the unemployment benefit, r, is equal to 0.5 and the value of home production, b, is just above 0.2. Compared to a market productivity of the low-skilled, z_l, equal to 1 these are high values, but observed European replacement rates are high, especially if one takes into account other benefits such as rent subsidies. Table 3 reports observed net replacement rates averaged across different beneficiaries and over the first five years of unemployment. Note that for several countries the replacement rates are above 50%.

3.3 Properties of the two steady states

Key properties of the two steady states are given in Table 4. The idea of this paper is that the period before the seventies corresponds to the low-unemployment steady state and the period after the 1970s to the high-unemployment steady state. Even though, the numerical exercises are mainly used to illustrate the properties of the model, we will compare the values generated by the model with their empirical counterparts to give the reader an idea of the order of magnitudes involved. The unemployment rate in the low-unemployment steady state is equal to 3.0% and in the high-unemployment steady state 11.8%. In the model, the magnitude of the increase is mainly determined by the assumption of how many workers are low skilled. Figure 1 plots the unemployment rate for the region consisting of France, Germany, and Italy. As documented by the figure, the increase in the observed European unemployment rate is similar to the difference between the unemployment rate in the high and the low-unemployment steady state in our model.

In the model, the rise in the unemployment rate goes hand in hand with a rise in the tax rate from 29.6% in the low-unemployment steady state to 35% in the high-unemployment steady state. Table 5 reports the observed overall tax burden for different subperiods and documents that across Europe the overall tax burden increased from 30.2% in the 1966-70 period to 37.1% in the 1976-82 period. Similar evidence is given in Figure 2 that plots total government outlays as a fraction of GDP for the U.S. and Europe, the latter again represented by France, Germany, and Italy. For the European countries considered, government outlays increased by five percentage points during the sixties. From 1970 to 1985, the increase accelerated and increased by 12 percentage points. After 1985 the ratio roughly stabilized until the mid nineties when a steady decrease set in. The acceleration of tax rates during

[10] See Den Haan, Ramey, and Watson (2000) for a detailed discussion of this issue.

the seventies is especially clear in panel B of Figure 2 in which we plot the difference between government outlays as a fraction of GDP in Europe relative to the US.

It is important to note that European tax rates already increased before the seventies, whereas European unemployment rates did not increase until the seventies.[11] In Section 8, we will argue that these earlier increases in tax rates may nevertheless not have been harmless for European labor markets.

In the model there are two reasons why taxes in the high-unemployment steady state are higher than in the low-unemployment steady state.[12] The first is that the increase in the number of unemployed means that the amount of unemployment benefits paid out by the government increases. Second, the increase in the unemployment rate also lowers the tax base, while government expenditures remain constant. Both factors are quantitatively important. In particular, unemployment benefits as a fraction of GDP increases from 1.1% in the low-unemployment steady state to 4.8% in the high-unemployment steady state, which explains roughly two third of the increase in the tax rate. How high unemployment benefits are in the data depends much on what is included. Table 6 reports transfers to the working-age population and shows that unemployment compensation by itself is at most a couple percentage points of GDP. Using only actual unemployment compensation transfers Saunders and Klau (1985) report how much the ratio of unemployment benefits to GDP has changed over the period from 1970 to 1981. The results are reproduced in Table 7. For the European average this ratio was in 1981 more than four times as big as in 1970.

But these numbers should be considered as a lower bound on the total amount of transfers that are paid because of dismal labor market conditions. One reason is that some unemployed are misclassified as sick or disabled and their compensation should be counted as part of the unemployment benefits paid out.[13] The reported numbers on total transfers to the working-age population include government expenditures such as expenses on housing benefits, family benefits, and early retirement that benefit the unemployed and are also related to labor market conditions. Of course, they also include transfers to the truly sick and disabled that are not directly affected by market conditions. Table 6 documents that total transfers are much larger and exceed 10 percentage points of GDP for several countries.

Moreover, transfers are not the only government expenditures that are related to labor market conditions. Examples are expenditures on labor market training, sub-

[11] As documented in panel B of Figure 2, however, European rates did not increase faster than U.S. rates during this period.

[12] The observed increase in tax rates is without doubt affected by other factors such as an increase in the level of unemployment benefits. See, for example, Table 35 in Saunders and Klau (1985).

[13] See, for example, Nickell and van Ours (2000).

sidized employment, employment services, and administration. The amount spent on these type of government programs is not necessarily small. For example, in 1995 Denmark spent 1.0 per cent of GDP on labor market training programs and 0.58 per cent of GDP on subsidized employment programs. Sweden spent in 1994-95 0.78 per cent of GDP on labor market training programmes and 0.90 per cent of GDP on subsidized employment.[14]

These numbers suggest that it is not unreasonable to argue that the higher unemployment rates in Europe have led to transfers that, as a per cent of GDP, are at least several points higher than their U.S. equivalents.

3.4 Laffer curve

It may be of interest to discuss whether the economy operates on the downward sloping part of the Laffer curve. When we look at total tax revenues as a function of the tax rate then this is not the case. Note that in the high-unemployment steady state the tax rate is higher but so are tax revenues (and equal to the higher level of total unemployment benefits plus the fixed other government expenditures). When we just focus on the low-skilled workers, however, then the economy is obviously situated on the downward sloping part of the Laffer curve, since at the high tax rate of the high-unemployment steady state the tax revenues from the low-skilled employed workers are zero, whereas they are positive at the lower tax rate of the low-unemployment steady state.

3.5 The high-unemployment steady state is a unique continuation equilibrium

If the economy starts out in a steady state then staying there is by definition an equilibrium time path. In this section, we address the question whether there are also other equilibria, that is, whether the steady states are unique continuation equilibria. It is easy to see that for the simple structure developed so far, the low-unemployment steady state is not a unique continuation equilibrium. Suppose, that at the beginning of a particular period, a low-skilled worker thinks that the other low-skilled workers would prefer non-market activities and that the economy will, thus, instantaneously switch to the high-unemployment steady state, then it would be optimal for him to prefer non-market activities. Such coordination of pessimistic believes—without any structural change—may be difficult to obtain in practice, especially when the economy is in the low-unemployment steady state, but

[14] See Table T in the statistical annex of OECD (1996).

the model cannot rule it out. In the next subsection, we will consider modifications of the model in which the low-unemployment steady state is a unique continuation equilibrium.

Now suppose that the economy is in the high-unemployment steady state. Because of the search friction, it is not possible to instantaneously move to the low-unemployment steady state. Of course, the economy could gradually move towards the low-unemployment state if all matches are accepted and lead to new jobs. There are many possible time paths that could move the economy out of the high-unemployment steady state. To prove that the high-unemployment steady state is a unique continuation equilibrium one has to consider the time path that has the best chance of success of getting out of the high-unemployment steady state. If even that fails, then the high-unemployment steady state must be a unique continuation equilibrium. To increase the chance of moving out of the high-unemployment steady state we would like to decrease taxes by the maximum amount possible.[15] The biggest decreases in tax rates would occur if all agents who are matched accept their new job and remain employed until they retire or exogenously separate. To see whether this is an equilibrium, we just have to calculate the implied time path for the unemployment rate, the tax base, and the tax rate. With these it is possible to calculate the continuation values, $g_{l,t}$ and $w_{l,t}$, and the surplus, $s_{l,t}$. If the surplus is positive for *all* periods during the transition, then this is an equilibrium time path. If even this time path—that leads to the biggest reductions in tax rates—does not get the economy out of the high-unemployment steady state, then no time path will, and the high-unemployment steady state is a unique continuation equilibrium.

As long as the high-unemployment steady state solution exists, we can easily find parameter values such that the high-unemployment steady state is a unique continuation equilibrium. The intuition is quite simple. For any set of parameter values we can always vary the value of b such that the surplus for the low-skilled jobs is barely positive (or zero) in the low-unemployment steady state. Note that being in a job while the economy moves towards the low-unemployment steady state is not as desirable as being in a job when the economy is already in the low-unemployment steady state. The reason is that tax rates are higher during the transition because of the higher unemployment rates. Consequently, the surplus of the low-skilled jobs would be negative during the transition, and this transition towards the low-unemployment steady state would not be an equilibrium.[16]

[15] Note that in this section we concentrate on balanced budget fiscal policy. The case where the governments is allowed to borrow is considered in Section 6.

[16] Since we assume that the government has a balanced budget it is also not allowed to save. If it could accumulate assets it could *raise* taxes in the high-unemployment steady state up to the point where the high-skilled workers are just willing to remain working. Note that this would not

3.6 Both steady states are unique continuation equilibria

In the model described above the low-unemployment steady state is not a unique continuation equilibrium, because the economy can instantaneously switch towards the high-unemployment steady state. In contrast, the matching friction prevents the economy from moving instantaneously from the high-unemployment steady state to the low-unemployment steady state. One possible way to make both steady states unique continuation equilibria is to introduce destruction and creation costs.[17]

Here we use a very simple modification of the model to ensure that switching instantaneously from the low to the high-unemployment steady state is not an equilibrium outcome. In particular, we assume that the productivity level of the low-skilled workers is non-constant and can take on two values, $z_{l,1} < z_{l,2}$. When a low-skilled job is created the value of z_l is drawn from $p^n(z)$. The transition of z_l for existing jobs is given by $p(z_l'|z_l)$. We assume that $p^n(z_{l,2}) = 0$, so that all new jobs start at $z_{l,1}$. This implies that it is possible to have a steady state in which all low-skilled workers are unemployed even when the surplus for a worker with a productivity of $z_{l,2}$ is positive. Necessary is merely that the surplus for the $z_{l,1}$ workers is negative so that low-skilled jobs are never created.

Assume that indeed it is the case that the value of $z_{l,2}$ is such that the surplus is positive even if other low-skilled jobs are unemployed. This means that a commonly held belief that the economy will move to the high-unemployment steady state will at most affect the low-skilled workers who are producing at $z_{l,1}$. The reason is that $z_{l,2}$ workers even have a positive surplus in the high-unemployment steady state, so they will obviously not break up if just the existing $z_{l,1}$ workers decide to break up. If the mass of $z_{l,1}$ workers is low enough then the increase in the tax rate triggered by the endogenous destruction of the $z_{l,1}$ jobs will not be high enough to justify the break-ups.

The second column of Table 2 gives parameter values such that both steady state solutions are unique continuation equilibria. For reasons similar to the ones given in the last subsection, it is easy to find parameter values such that one of the two steady states is a unique continuation equilibrium. For high values of the discount factor, it is more difficult to find one set of parameter values such that both steady states are unique continuation equilibria. The reason is that the values of the surplus

affect the unemployment rate. When the government has accumulated enough assets to finance the transition to the low-unemployment steady state, it can lower taxes. This peculiar result would, of course, disappear when a richer distribution of productivity levels was used, for which there would be marginal jobs in the high-unemployment steady state that would suffer from the increase in tax rates.

[17] An earlier version of the paper did include destruction and creation costs. But the analysis becomes more difficult, since the possible time paths one has to consider increases quite a bit.

(through changes in the continuation values) are heavily influenced by the fact that the path considered leads the economy to the other steady state, where it will then stay *permanently* and that this happens with perfect certainty. The discount factor considered here, for which both steady states are unique continuation equilibria, is equal to 0.94, while we used 0.99 in the last subsection.[18] As was the case considered above, all low-skilled workers are unemployed in the high-unemployment steady state. Consequently, the steady state unemployment rates as reported in Table 4 remain unchanged.

4 One Time Shocks

Above, we have asked the question whether self-fulfilling expectations could drive the economy out of a steady state. Although this is a possibility for some parameter values, we focus from now on on the case discussed in Section 3.6 for which both steady states are unique continuation equilibria. The motivation for doing so is that economies do not seem to move that easily between high and low-unemployment regimes.

In this section, we discuss how the economy responds to one time shocks.[19] In the first subsection, we discuss shocks that occur when the economy starts out in the low-unemployment steady-state. We address the question whether there are shocks that are so bad that the economy cannot move back to the low-unemployment steady state. In the second subsection, we consider the case when the shock occurs when the economy is in the high-unemployment steady state. In the third subsection, we discuss related literature.

4.1 Shocks in the low-unemployment steady state

The aggregate shock considered here is a one-time change in the rate of exogenous break-ups. This will allow us to draw conclusions from any increase in the unemployment rate.[20] The first question addressed here is whether—after the shock has

[18] Below, we discuss an alternative (and rather special) driving process for z for which both steady state are unique continuation equilibria when β is equal to 0.99.

[19] The analysis here is related to Den Haan, Ramey, and Watson (2003). In this paper a one-time shock reduces the number of lenders that are in a relationship and leaves the health of the financial system in worse shape. There the question is whether the economy can converge back towards the steady state or will completely collapse.

[20] Given the limited amount of heterogeneity in the numerical example used here, this would not be the case if we would consider one-time changes in aggregate productivity. Also note that when aggregate productivity changes, there would be a reduction in the output levels of the continuing

increased the unemployment rate—the economy could converge back towards the low-unemployment steady state. The second is whether it could converge towards the high-unemployment steady state.

The approach used to answer these questions is very similar to the method used to check whether a steady state is a unique continuation equilibrium. That is, to check whether the economy can converge back towards the low-unemployment steady state, we consider the time path that is most likely to keep the surplus on the path positive. Similarly, to check whether the economy could move towards the high-unemployment steady state we consider the time path that is most likely to keep the surplus negative.

Before we start the discussion it may be worthwhile to point out that the economy can always move towards at least one of the two steady states. The reason is that along the transition to the high-unemployment steady state, the tax rates are increasing and the surplus values are decreasing. The opposite is true along the transition towards the low-unemployment steady state. Suppose that after a shock the economy cannot move towards the high-unemployment steady state. This means that initially the surplus is still positive despite the bleak future facing the worker. But this means that when the worker would face the better path towards the low-unemployment steady state, the surplus would be even higher and consequently this would be an equilibrium.

4.1.1 Small shocks and large shocks.

Suppose the economy is in the low-unemployment steady state and a fraction of low-productivity jobs is destroyed. This shock will lead to an increased obligation of the government to pay unemployment benefits and necessarily to an increase in tax rates even if the economy moves back towards the low-unemployment steady state. For a small enough shock, it is not possible that the economy will converge towards the high-unemployment steady state, if staying in the low-unemployment steady state is a unique continuation equilibrium.[21] If even the time path that results in the highest possible tax rates keeps the surplus at least initially positive, then existing

relationships. This would make it somewhat harder to return to the low-unemployment steady state after a shock. Since the reduction in aggregate productivity is only for one period, this effect would be quantitatively small.

[21] If staying in the low-unemployment steady state is a unique continuation equilibrium, then the belief, formed at the beginning of period $t = 1$ that the economy will move out of the steady state−without a change in any of the fundamentals−leads to a time path with $s_{l,t}(z_{l,1}) > 0$ for some $t \geq 1$. Continuity of $s_{l,t}(z_{l,1})$ then guarantees that $s_{l,t}(z_{l,1})$ remains positive in response to small changes in the fundamentals, which is inconsistent with the assumption that relationships are breaking up and that the economy is moving to the high-unemployment equilibrium.

jobs will remain viable. Consequently, the unemployment rate will decrease and the economy will converge back towards the low-unemployment steady state.

Clearly there are large enough shocks such that the economy will end up in the high-unemployment steady state. In particular, suppose that there is a one-time sharp reduction in the productivity level of the low-productivity relationships that is so large that the surplus values of all low-skilled workers become negative. This leads to these relationships breaking up and as a result of this (temporary) change in a fundamental, the economy moves to the high-unemployment steady state instantaneously. Since the high-unemployment steady state is a unique continuation equilibrium, the belief that the economy will converge back to the low-unemployment steady state cannot push the economy out of the high-unemployment steady state after productivity levels have recovered. Similarly, shocks that lead to unemployment rates close enough to the level of the high-unemployment regime cause an inevitable transition to the high-unemployment steady state.[22]

4.1.2 Intermediate shocks

Above, we have shown that if the shock is small enough, the economy has to move back to the low-unemployment steady state, while if the shock is large enough the economy has to move to the high-unemployment steady state. Not surprisingly, there are intermediate shocks for which the economy could either move back towards the low-unemployment steady state or move towards the high-unemployment steady state. Figure 3 plots the time path for the unemployment rate after the largest possible increase in the unemployment such that it is still possible to move back to the low-unemployment steady state. That is, for any shock that leads to an increase in the unemployment rate (starting at the 3% steady state value) to a value above 8.5%, the time path towards the high-unemployment steady state is the unique equilibrium. The figure also plots the unemployment rate towards the high-unemployment steady state for the smallest shock such that convergence towards the high-unemployment steady state is still possible. For this time path the unemployment rate jumps from 3% to 6% after which it continues to increase.

If the economy is in the region where expectations matter, the difficult question arises how expectations will be formed and what path the economy will actually follow. Moreover, if self-fulfilling expectations are possible then—besides the two time paths that lead directly to one of the two steady states—other time paths are possible too.

The analysis here shows that this indeterminacy is not present if the shock is

[22] Again the reason is the continuity of the surplus and the property that the high-unemployment steady state is a unique continuation equilibrium.

big enough. So, for the discussion of European unemployment rates, it is, therefore, most interesting to ask whether there are shocks which are so large that return to the low-unemployment steady state is not possible. The reason is that the matching friction keeps the unemployment rate above the low-unemployment steady state value *even if* the economy moves back towards the low-unemployment steady state. If the shock is high enough then this implies tax rates, which are so high that the surplus values along the transition are not always positive, which means that this is not an equilibrium time path.

4.2 Shocks in the high-unemployment steady state

Analogous, the question arises how large the shocks must be to get the economy out of the high-unemployment steady state and on a time path towards the low-unemployment steady state. Above, we discussed that if a one-time shock to aggregate productivity is sufficiently large, the economy can deteriorate so much that return towards the low-unemployment steady state is impossible even though the shock is temporary. It could be the case that the high-unemployment steady state is more stable in the sense that no one-time shock of any size can put the economy on a time path towards the low-unemployment steady state.

The reason is the search or matching friction. Suppose that in one particular period economic conditions are so good that even the least productive worker would accept a job offer. Since not all workers find a match the unemployment rate only drops by a limited amount. The problem is that after this reduction, the level of the unemployment rate may still be too high to make convergence towards the low-unemployment steady state possible. For the parameters given in the first column of Table 2, all job offers must be accepted for at least twelve periods before the unemployment and tax rates have dropped to a level for which low-skilled jobs have become viable at normal values of aggregate productivity and the economy could converge towards the low-unemployment steady state. How asymmetric the effects of shocks in the two steady states are depends, of course, on the surplus values in the two steady states. If the surplus of the low-skilled workers in the low-unemployment steady state is barely positive, then it would require positive shocks for many periods before the economy converge towards the low-unemployment steady state. In particular, suppose that we increase the value of b so that the surplus value for the low-skilled jobs in the low-unemployment steady state approaches zero. Then the number of periods that workers must accept jobs before the unemployment rate has reached a level at which moving towards the low-unemployment steady state is an equilibrium goes to infinity.[23]

[23] Because of the matching friction, the unemployment rate at best approaches the steady state

4.3 History and expectations in the literature

There are other ways in which one can generate multiple steady states with different levels of the unemployment rate. For example, Diamond (1982) develops a model in which an externality in the search technology (to find buyers for produced products) generates multiple steady states. Saint-Paul (1995) develops a model in which the existence of firing costs generates multiplicity. The idea of the latter paper is that if the unemployment rate is high (low), employed workers are less (more) likely to quit voluntarily, which means that employers are less (more) likely to post vacancies, which implies indeed a high (low) unemployment rate. Finally, Ortigueira (2002) analyzes a model in which human capital does not affect the enjoyment of leisure or the productivity of search but does affect market production and education. In this model a high (low) initial level of human capital leads to a balanced growth path with high (low) growth and low (high) unemployment. Ortigueira (2002) also shows that unemployment benefits increase the vulnerability of the economy to employment shocks, which is related to our discussion in this section.

This paper analyzes the role of history versus expectations in determining to which steady state the economy will converge. In some models with multiple steady states the equilibrium is unique so that only history determines to what equilibrium the economy will converge. For example, in the growth theory on poverty traps, the current aggregate capital stock captures the past history and conditional on the current capital stock the choice for next period's capital stock is uniquely determined.[24] In this paper, the current (un)employment pool is a state variable that captures past history and plays a role similar to the capital stock in growth models. In particular, we have shown that if the unemployment rate is high enough the economy can only converge towards the high-unemployment steady state. But the analogy only goes so far, since we also find that for some values of the unemployment rate expectations do matter.

The discussion on history versus expectations has been explored in the literature but, probably because of the technical nature, only in a few papers.[25,26] I am not aware of any papers that address this question in models with search or matching frictions even though they provide an excellent framework to study this question.

value and so—compared to the low-unemployment steady state values—the tax rate will at least be somewhat higher and the surplus, thus, less than zero.

[24] See Section 1.3.5 in Barro and Sala-i-Martin (1995).

[25] Models with sun spots solutions have, of course, received a lot of attention in macro economics, but the existence of sun spot solutions depends on structural parameters (such as the size of increasing returns) not on the value of the state variable.

[26] Krugman (1991) gives an excellent discussion of different views in the literature on the importance of history versus expectations for economic outcomes.

Krugman (1991) uses a simple two-sector model from the international-trade literature in which the productivity of an individual firm in producing one of the two commodities depends on aggregate employment in that sector and is thus subject to an externality. Parameters are such that the two possible steady states are then specialization in one of the two commodities. Dynamics are introduced by assuming that movements of aggregate employment across sectors are costly. To determine the dynamics in the market economy, Krugman (1991) constructs a hypothetical claim on the difference between the private values of having a unit of labor in the two sectors. Matsuyama (1991) generalizes Krugman (1991) by introducing nonlinearities and, thus, allows for interior steady states. An appealing feature of Matsuyama (1991) is that he models sluggish adjustment directly at the micro level as opposed to assuming adjustment costs for aggregate employment. In particular, he uses an overlapping generations setup in which agents choose their preferred sector of employment when young after which it cannot change.[27]

In the current paper, the externality is generated by taxes and the sluggish adjustment is generated by the matching friction as well as the upgrade possibility. Although the model in this paper is less abstract than those in Krugman (1991) and Matsuyama (1991), the ideas behind the mechanics are very similar. Moreover, all three papers find that there is a range of values for the state variable in which history only determines the dynamics, but that there is range in which expectations matter.

There is an important difference, however, between the application here and those considered in the literature. Here, the state variable is the fraction of unemployment (or employed) workers. In Krugman (1991) and Matsuyama (1991) it is the fraction of workers in the first (or second) sector and in Zilibotti (1995) it is the capital stock. Consequently, in the application here the role of "history" becomes a lot more interesting, since one can imagine (one-time) shocks that generate sudden changes in the state variable of this paper. That is, while it is quite natural to think of unemployment quickly rising during recessions one cannot think of similar shocks that would generate similar movements across sectors or sudden decreases in the capital stock.

Finally, the question arises how to select an equilibrium in the range where multiple equilibria are possible. Morris and Shin (1998) point out that the multiplicity may not be as robust as one would think. In particular, they consider a model in which a state variable characterizes the strength of the currency and speculators

[27] Also related is the analysis of Zilibotti (1995) who considers multiplicity in a growth model for low initial capital values. Interestingly, in one case considered the non-unique time paths all converge towards the stationary steady state (threshold models), whereas in the alternative case some of the non-unique time paths do lead to sustained growth.

decide whether to attack the currency or not. Similar to the results in this model, they find that for low values of the state variable a currency attack is the only equilibrium, for high values no attack is the only outcome, and for intermediate values multiple equilibria exist.[28] Morris and Shin (1998) make clear that essential for the multiplicity is that knowledge of the underlying state variable is common knowledge. When agents observe noisy and different signals of the state variable, the coordination that allows multiplicity to exist breaks down and the equilibrium is unique. That is, there is a cut off value for the state variables that determines whether a currency attack takes place or not. Obviously, a market with currency traders is not identical to a market with employers and employees, because in the latter agents may have more time to coordinate on their believes about the underlying state variable. So other mechanisms may be important and in particular there may be a role for the government in affecting the expectations of the private sector.

5 Unraveling of the low-unemployment equilibrium

In the benchmark model described above, there were only two skill levels and in the simplest parameterization all low-skilled workers had the same productivity level. In this set up a minuscule change in the tax rate can lead to a large change in the unemployment rate, if the surplus value of these low-skilled workers is close enough to zero. One may think that having this concentration of workers' productivity levels is a necessary condition. In this section, we show that this is not true in the sense that even if there are multiple productivity levels, a tiny initial change in the tax rate can still lead to a large change in employment through a domino effect. It is true, however, that the distribution of workers' productivity levels should be "dense enough", a condition obviously satisfied in the example above in which all low-skilled workers had the same productivity level.

To simplify the analysis, we consider a static version of the model. We assume that workers have different productivity levels, $z_1 \leq z_2 \leq \cdots \leq z_N$, where N can be arbitrarily large. To simplify the exposition we assume that there is equal mass at each productivity level. As before, tax rates are assumed to be proportional.[29] The surplus is defined by

$$s_n(z_j) = (1 - \tau_n)\ z_j - b - r, \tag{7}$$

[28] Multiplicity occurs because the costs for the government of defending the currency depend on the fraction of agents attacking the currency.

[29] The results are also valid with lump sum taxes and the reader can easily verify that the algebra is simpler in that case.

where $s_n(z_j)$ is the value of the surplus of worker with skill level j when n workers are unemployed. Note that $s_n(z_n)$ is the surplus value of the most productive worker for whom market production is not the preferred choice. Also, τ_n is the tax rate when n workers are unemployed. Thus,

$$\tau_n = \frac{nr}{\sum_{i=n+1}^{N} z_j} = \frac{nr}{Z - \sum_{i=1}^{n} z_j}, \tag{8}$$

where $Z = \sum_{i=1}^{N} z_j$. Since this is a static version of the model, we do not have to worry about upgrades or matching. Before we give the main result it is useful to look at the following two lemmas that determine how the surplus of the n^{th} agent changes with n, the number of agents that are unemployed.

Lemma 1 *Assume that $r > 0$ and $z_j = \varepsilon\ z_{j-1}$ with $\varepsilon \geq 1$ for $j > 1$. Then*

$$(\tau_{n+1} - \tau_n)$$

is strictly increasing in n.

Proof. Let $\Lambda_n = (1 + \varepsilon + \varepsilon^2 + \cdots + \varepsilon^n)$. Then the definition of the tax rate and simple algebra gives

$$\begin{aligned}
\tau_{n+1} - \tau_n &= r\left(\frac{n+1}{Z - \sum_{i=1}^{n+1} z_i} - \frac{n}{Z - \sum_{i=1}^{n} z_i}\right) \\
&= r\left(\frac{n+1}{Z - z_1(1 + \varepsilon + \varepsilon^2 + \cdots + \varepsilon^{n+1})} - \frac{n}{Z - z_1(1 + \varepsilon + \varepsilon^2 + \cdots + \varepsilon^{n})}\right) \\
&= r\left(\frac{n+1}{Z - z_1(\Lambda_n + \varepsilon^{n+1})} - \frac{n}{Z - z_1\Lambda_n}\right) \\
&= r\left(\frac{1}{Z - z_1(\Lambda_n + \varepsilon^{n+1})} + \frac{z_1 n\varepsilon^{n+1}}{(Z - z_1(\Lambda_n + \varepsilon^{n+1}))\,(Z - z_1\Lambda_n)}\right),
\end{aligned}$$

which is increasing in n. ■

Lemma 2 *Assume that $r > 0$ and $z_j = \varepsilon\ z_{j-1}$ with $\varepsilon \geq 1$ for $j > 1$. Let $\Gamma_{n+1} = (\varepsilon - 1)(1 - \tau_{n+1}) - (\tau_{n+1} - \tau_n)$. Then*

$$s_{n+1}(z_{n+1}) - s_n(z_n) = \Gamma_{n+1} z_n$$

and Γ_n is strictly decreasing in n.

Proof. Simple algebra gives that

$$\begin{aligned} s_{n+1}(z_{n+1}) - s_n(z_n) &= [(\varepsilon - 1)(1 - \tau_{n+1}) - (\tau_{n+1} - \tau_n)]\, z_n \\ &= \Gamma_{n+1} z_n. \end{aligned}$$

The first lemma shows that $(\tau_{n+1} - \tau_n)$ is increasing in n, which together with the property that τ_{n+1} is increasing in n proves that Γ_{n+1} is decreasing in n. ■

Note that at this point we are not concerned about the sign of the surplus, or more precisely whether the value of n is consistent with the sign of the surplus. What the lemmas show is that the increase in tax rates accellerates as n increases and that this is reflected in the change in the surplus value of the marginal worker. The intuition for this result is that when the productivity of the next more productive worker is at best $(\varepsilon - 1)\%$ higher, the increase in the productivity level is not enough to offset the effect of the reduction in the tax base.

The main result of this section is given in the following proposition.

Proposition 3 *Suppose that the following holds:*

- $\exists \overline{n}$ *such that* $s_{\overline{n}}(z_{\overline{n}}) = 0$ *and* $s_{\overline{n}+1}(z_{\overline{n}+1}) < 0$,
- *Assume that* $r > 0$ *and* $z_j = \varepsilon\ z_{j-1}$ *with* $\varepsilon \geq 1$ *for* $j \geq \overline{n} + 1$,
  Then $s_k(z_k) < 0$ *for* $k > \overline{n} + 1$.

Proof. The first condition implies that $\Gamma_{\overline{n}+1} < 0$. The second lemma then implies that $\Gamma_{\overline{n}+2} < \Gamma_{\overline{n}+1} < 0$. This implies that

$$s_{\overline{n}+2}(z_{\overline{n}+2}) = s_{\overline{n}+1}(z_{\overline{n}+1}) + \Gamma_{\overline{n}+2}\ z_{n+1} < 0.$$

Simple iteration completes the proof. ■

The first assumption says it is an equilibrium for $\overline{n}$ workers to be unemployed and that the productivity level of the worker with skill level $\overline{n} + 1$ is close enough to the level of the worker with skill level $\overline{n}$, so that if the $(n+1)^{\text{th}}$ worker becomes unemployed, the increase in the tax rate will be large enough to make his surplus negative. Consequently, it is also an equilibrium for $\overline{n}+1$ workers to be unemployed. The assumption that $s_{\overline{n}}(z_{\overline{n}}) = 0$ implies that $s_{\overline{n}}(z_{\overline{n}+1})$ is positive as long as $z_{\overline{n}+1} > z_{\overline{n}}$. Note that, by considering the borderline case with $\overline{n}$ unemployed workers and $s_{\overline{n}}(z_{\overline{n}}) = 0$ (as opposed to the case where $s_{\overline{n}}(z_{\overline{n}}) < 0$), we make the marginal employed worker as secure as possible.

The second assumption is a condition on how clustered the productivity levels are. Obviously, one can replace this condition with the assumption $z_{j+1}/z_j \leq$

$z_{\overline{n}+1}/z_{\overline{n}}$ for $j > \overline{n}+1$, which would imply that the productivity levels are even closer together. Both assumptions are stronger than needed and the growth rate in productivity levels actually could increase with j. But not by too much and the point of this proposition is that if there no sufficiently large "gaps" between productivity levels, the economy could unravel. That is, unraveling is possible if the values of z_j are "close enough".

The intuition behind this result is that if the increase in the tax rate caused by the $(n+1)^{th}$ worker becoming unemployed is sufficiently large to make employment unattractive for this worker, then the increase in the tax rate caused by the workers with higher skill levels becoming unemployed is sufficient to make employment unattractive for them as well.

Note that the proposition does not say that the economy necessarily unravels, it only says that it could. In fact, the case with $n = \overline{n}$ $(< N)$ is by construction an equilibrium. What the proposition implies is that if the distribution is sufficiently dense, then the economy could unravel.There may be several other equilibria.

6 Tax now versus Tax later

So far we have assumed that the tax rate is set each period to balance the government budget. In this section, we will consider the case where the government is allowed to borrow. We will start with the case where—as before—the government is passive and takes the expectations of the private sector as given. In the second subsection, we briefly discuss the case where the government sets the tax rate first. The last subsection discusses the relation with the literature.

6.1 Government takes expectations of private sector as given

Note that the model does not satisfy the Ricardian equivalence property, since an employed worker would rather be taxed in the future when he may face lower tax rates (either because he is unemployed or because he is dead). Besides allowing the government to borrow, there are many other interesting tax policies that one could consider. For example, instead of subsidizing the unemployed one could subsidize low-skilled workers either by explicit subsidies or lower tax rates. These alternatives are not considered here.

We consider again the direct time path from the high-unemployment steady state towards the low-unemployment steady state that minimizes the unemployment benefits the government has to pay out.[30] That is, we consider the time path where

[30]So we do not consider the case mentioned above where the government first raises tax rates

every new match leads to a new job and nobody chooses to leave employment. We start by looking at the case where z_l can take on only one value. For the parameter values considered above we know that this time path is not an equilibrium when the government balances the budget each period.

Now consider the tax policy that chooses one constant tax rate such that the net present value of government revenues is equal to the net present value of government expenditures. We will refer to this policy as the balanced-NPV fiscal policy. In Figure 4 we plot the tax rate under this policy and under the balanced-budget policy when the economy moves from the high-unemployment steady state to the low-unemployment steady state. Note that the tax rate under the balanced-budget policy basically follows the time path of the unemployment rate. Figure 4 documents that if the government follows the balanced-NPV policy the tax rate drops immediately and is for several periods below the tax rate under the balanced-budget policy but, of course, at some point the tax rate under the balanced-budget policy will be lower.

For the balanced-budget policy the surplus of low-skilled workers is initially negative, which is the reason why this is not an equilibrium time path. Since employed workers rather have a tax cut now then later, the time path towards the low-unemployment steady state has a better chance of being an equilibrium under the balanced-NPV fiscal policy. However, for the parameters used here the time path towards the low-unemployment steady state is not an equilibrium under the balanced-NPV policy either.

Our balanced-NPV fiscal policy implies a constant tax rate, but there are, of course, other fiscal policies for which the NPV of the tax revenues equals government expenditures. If the transition is not an equilibrium under the balanced-NPV with a constant tax rate, then it is not an equilibrium for any time path of government debt that satisfies the intertemporal budget constraint. To understand why suppose that under the balanced-NPV fiscal policy the transition is not an equilibrium. This means that the (constant) surplus value of low-skilled jobs is negative at this tax rate. The government could lower the tax rate initially until the surplus of the low-skilled jobs would be positive. This positive surplus value would be consistent with the assumption that workers accept new jobs.. But the government would have to pay for this initial additional tax reduction by raising the tax rate at some point in the future, since the NPV of the benefits the government has to pay out is unchanged. But if the surplus is already negative at the original tax rate it will definitely be negative if the tax rate at some point will be above the balanced-NPV value. And this negative surplus value is not consistent with the assumption that

on the (secure) high-skilled workers until it has build up enough funds to finance the transition towards the low-unemployment steady state.

workers accept new jobs.

The analysis above assumes that $z_{l,1} = z_{l,2}$. Under this assumption it is more likely that the economy can leave the high-unemployment steady state if the government follows a balanced-NPV policy fiscal policy as opposed to a balanced-budget fiscal policy. If $z_{l,1} < z_{l,2}$ this is not necessarily true, although the numerical results indicate that $z_{l,1}$ has to be substantially below $z_{l,2}$ to turn around this result. The intuition is as follows. As before, suppose that the parameters are such that in the high-unemployment steady state the surplus of workers at $z_{l,1}$ is negative and the surplus of the workers at $z_{l,2}$ is positive. Workers with $z_{l,2}$ jobs still do not exist in the high-unemployment steady state since all new jobs always start at $z_{l,1}$. For the transition to the low-unemployment steady state to be an equilibrium we need to make the surplus of the $z_{l,1}$ guys positive. But if $z_{l,1}$ is substantially below $z_{l,2}$ then these workers would rather be taxed at a high rate now (when their income is low) than later (when they are likely to earn $z_{l,2}$). This implies that taxing now (i.e., a balanced-budget fiscal policy) may be better for the low-skilled workers than taxing in the future (i.e., a balanced-NPV fiscal policy). A numerical example in which this is the case, is given in the third column of Table 2. For this parameter set the direct time path towards the low-unemployment steady state is an equilibrium under the balanced-budget fiscal policy, but not under the balanced-NPV fiscal policy.

6.2 Fiscal policy with commitment

In the last subsection, we assumed that the government takes the expectations of the private sector as given and sets tax rates accordingly. Under that assumption, there are parameter values such that staying in the high-unemployment steady state is not a unique continuation time path if the government implements a balanced-NPV fiscal policy.[31] In this section we address the question whether the government in that case could select the equilibrium time path that converges to the low-unemployment equilibrium by simply choosing the lower tax rate that corresponds to the transition to the low-unemployment steady state. At this tax rate the surplus values for all productivity levels are positive, and the government balances the present value of its revenues and expenditures. One might be tempted to conclude that by committing to this tax rate the government eliminates staying in the high-unemployment steady state as an equilibrium. Consequently, the only remaining equilibrium is the time path towards the low-unemployment steady state. Bassetto (2002) points out this establishes the uniqueness of an equilibrium but under the assumption that the pri-

[31] For example, if the value of b in the first column of Table 2 drops to 0.26, then the high-unemployment steady state would not be a unique equilibrium under the NPV-balanced fiscal policy but would be under the balanced-budget fiscal policy.

vate sector believes that the government will act in a way that is simply impossible under off-equilibrium scenarios. In particular, suppose that (part of) the private sector does not believe that the economy will converge towards the low-unemployment steady state. Under the assumption that the government commits to a low tax rate, the present value of government expenditures and revenues are no longer equal. It is unclear what would happen under this scenario. It is possible that the government would break its commitment. Since one cannot evaluate the alternatives, one also cannot conclude there is not an equilibrium among the alternatives. Theoretically, an easy way out of this problem is to assume that the government commits to a low tax rate *and* that government expenditures, gov_t, will adjust to ensure that the NPV of the government's budget deficits is equal to zero. With this modification the time path along which the economy moves to the low-unemployment steady state is the unique equilibrium. In equilibrium, the government would not have to adjust the level of government expenditures, but to have proper uniqueness we have to assume that the government will do so along off-equilibrium time paths.[32] Although the assumption that the private sector believes the government will adjust government expenditures is convenient from a theoretical point of view, it has to be pointed out that this is not the most realistic assumption.

6.3 Fiscal policy and stability in the literature

In a classic paper, Schmitt-Grohé and Uribe (1997) argue against a balanced budget-fiscal policy by showing that they can make expectations of higher (lower) tax rates self-fulfilling. In contrast, in this paper a balanced-NPV fiscal policy is more likely than a balanced-budget fiscal policy to make expectations of higher (or lower) tax rates self-fulfilling. The reason for the difference is that Schmitt-Grohé and Uribe (1997) consider indeterminacies around one unique steady state whereas we consider different steady states. In this paper, a balanced-NPV fiscal policy reinforces the expectations of the private sector and, thus, makes them more likely to become true.

For example, suppose that in response to a negative shock the private sector becomes pessimistic and believes that the economy will move towards the high-unemployment steady state. It is possible that this is an equilibrium under the balanced-NPV fiscal policy, where the government raises the tax rate immediately, but not under a balanced-budget policy, where the government only raises tax rates as the expected increases in the unemployment rate actually occur.

The policy recommendations are, thus, somewhat different than in Schmitt-Grohé and Uribe (1997), although not as much as the discussion above might sug-

[32] Note that we also could make unemployment benefits the residual in the government's fiscal policy.

gest. In the case discussed in the last paragraph, a balanced-budget fiscal policy is indeed preferred, but it is unlikely that governments would choose to follow a balanced-NPV fiscal policy in this case in which the private sector expects to move out of the low-unemployment steady state and the government takes expectations as given.

The more interesting case is the one when the economy starts out in the high-unemployment steady state. In this case—just as in Schmitt-Grohé and Uribe (1997)—it is better to follow a balanced-NPV fiscal policy, although now it is because this makes it more likely that expectations of lower tax rates are self-fulfilling. The most interesting difference in terms of policy recommendations between this paper and Schmitt-Grohé and Uribe (1997) is the case where the value of $z_{l,1}$ is substantially below $z_{l,2}$. Above we have shown that in this case it actually may be better to have a balanced-budget, even if unemployment rates are high. The reason is that startup companies prefer high tax rates at the beginning of the transition when they are not making much money anyway.

7 Quantitative effect of taxes on employment

There is a large empirical and theoretical literature that tries to answer the question whether the effect of tax rates on aggregate employment is quantitatively important.[33] Precise estimation of the quantitative effect of changes in tax rates is hampered by several factors such as the difficulty to construct the relevant tax measure, impossibility to control for all other relevant factors, endogeneity of explanatory variables, and heterogeneity.[34] Not surprisingly, there is no consensus regarding the quantitative importance of tax rates for aggregate employment.

Recently, two empirical studies have argued that the effects are stronger than previous studies have indicated. The first study is Daveri and Tabellini (2000), who argue that previous studies underestimated the effect of taxes because they did not control appropriately for the different wage setting institutions and did not use observed time variation in tax rates.[35] Their estimates of the effect of a one percentage point increase in the effective tax rate on the unemployment rate for continental Europe range from about 0.3 to over 0.5. Their estimates for the Nordic and Anglo-Saxon countries are lower. Prescott (2003) constructs new empirical measures for the effective marginal tax rates and, employing a fairly standard representative agent

[33] Excellent discussions can be found in Pissarides (1998) for the theoretical arguments and in Disney (2000) and Nickell (2004) for the empirical findings.

[34] See, for example, Disney (2000).

[35] Nickell (2004) in turn argues that Daveri and Tabellini (2000) exclude important control variables.

model, finds that differences in the marginal tax rate account for the predominance of the differences in employment rates across countries as well as the changes over time.[36]

This paper establishes a new channel through which tax rates affect employment by considering at the effect of changes in tax rates on the decision to engage in market production.[37] As explained below, the paper highlights that the effect of tax rates on employment can be quantitatively important even under conditions for which changes in the tax rate would have a minimal effect on employment in existing theoretical models. In addition, it reveals another caveat that makes it difficult to accurately estimate the effect of tax rates on employment.

In the rest of the section we briefly summarize the theoretical debate and continue by relating the framework developed here to the literature.

7.1 Existing theoretical literature

In the existing theoretical literature, the elasticity of the labor supply with respect to the after-tax wage rate plays a key role. An increase in the tax rate decreases the relative price of leisure and leads to a reduction of the labor supply (substitution effect), but it also leads to a decrease in income which leads to a decrease in consumption and an increase in the labor supply (income effect). Empirical studies imply low elasticities and for middle-aged men the elasticity has even been found to be negative, implying that the income effect would dominate the substitution effect.[38] Higher elasticities are found, however, for other types of workers.

The substitution effect is of course determined by changes in the marginal tax rate. It is harder to understand which combination of both current and future tax rates determines the income effect. Prescott (2003) avoids this problem by using the observed ratio of aggregate consumption to GDP to capture the income effect.[39] It is important to note, however, that an important fraction of the predicted changes reported in Prescott (2003) are due to changes in this consumption ratio. For example, for Germany the increase in the consumption to GDP ratio from 0.66 in the 1970-74 period to 0.74 in the 1993-96 period explains 40% of the predicted

[36] Moreover, Alesina, Ardagna, Perotti, and Schiantarelli (2002) document that tax rates have a quantitatively important negative effect on investment.

[37] Note that even Pissarides (1998), who considers matching models, does not allow for endogenous destruction.

[38] See Disney (2000) and Pissarides (1998) for a discussion.

[39] Prescott (2003) constructs marginal tax rates by multiplying the average income tax rate (excluding social security premiums) with 1.6. He provides evidence using US data, but a comparison of the marginal and average tax rates on labor income given in Table 1 of Sørensen (1997) suggest a much smaller factor.

decrease in labor supply. Although the observed increase in the consumption ratio helps Prescott to match the observed decreases in European labor supply, one has to keep in mind that the model predicts that an increase in tax rates should lead to a reduction in the consumption ratio, unless the observed increase in the marginal effective tax rate corresponds to a decrease in the overall tax burden. In fact, Prescott (2003) uses a model in which the substitution effect and the income effect of a change in a proportional tax rate exactly offset each other and, thus, leave labor supply unaffected.

Prescott (2003) assumes that wages are set in competitive markets, but several authors have pointed out that this is not an appropriate assumption for the case of Europe.[40] Moreover, as Sørensen (1997) points out

> *It is quite striking that all of the modern labour market theories capable of explaining involuntary unemployment as an equilibrium phenomenon imply that increased tax progressivivity (a rise in the marginal tax rate for a given average tax rate) will moderate wages and promote employment, whereas a rise in the average tax rate will tend to drive up the wage level.*

The intuition is that in models in which employers bargain with unions or workers, an increase in the tax rate on labor income makes it easier for workers to concede to reductions in the wage rate. Moreover, Pissarides (1998) points out that these effects are quantitatively important as long as unemployment benefits are not indexed to wages.

7.2 What is different in this paper?

Note that in our model tax rates could affect employment even if there is no disutility of leisure. What matters is that there are alternatives to market production such as receiving unemployment benefits (captured by r) and/or non-market activities (captured by b).[41] The model is, thus, in spirit similar to Davis and Henrekson (2004) who stress the importance of substitution out of market production to understand the effects of changes in tax rates on work activity.

Our paper stresses the importance of tax rates on the destruction margin. This channel not only changes the conditions under which changes in the tax rates have large effects, it also changes the view on what the appropriate controls are in empirical studies. Whereas the literature typically analyzes the intensive margin and, thus,

[40] See, for example, Pissarides (1998) and Sørensen (1997).

[41] Of course, the parameter b could also capture benefits of leisure.

focuses on the *marginal* tax rate for additional hours worked, this study stresses the extensive margin and, thus, the importance of the tax rate on market income *relative* to the tax rate on non-market income.

Furthermore, in the literature the magnitude of the elasticity of the labor supply with respect to changes in the after-tax wage rate is important in determining the quantitative effect of changes in tax rates. In contrast, in our framework, the mass of those jobs that are close to the breakup margin determines the magnitude of the effect. If the mass of jobs close to the breakup margin is large, then small changes in tax rates could have large effects. Since the distribution of the surplus is affected by many factors, such as human capital, institutions, industrial composition, one cannot expect the distribution to be very similar across countries or across time. Consequently, the effect of tax rates varies across countries and across time and in order to predict the effect of a change in the tax rate accurately one would need information about the distribution of the surplus.

The result that tax rates are particularly important for low-surplus jobs is consistent with the empirical finding that tax rates are important for the labor supply of low-income earners, older workers, and those considering entering the labor force.[42] Note that older and younger workers may not only have a lower market productivity but also an attractive outside option (retirement and education). Moreover, this observation is also consistent with the policies pursued by some governments to give tax relief to low-income earners.[43]

8 Employment versus unemployment rates

In this paper, the employment and unemployment rate always move in opposite directions. Empirically, however, this is not the case. In particular, the following observations can be made about the behavior of employment rates.

- As documented by Rogerson (2003), employment rates in Europe and the U.S. started to diverge before the 1970s, whereas for unemployment rates that is not true. This is confirmed in Figure 5 that plots employment rates by sex for the U.S. and for the group of countries consisting of France, Germany, and Italy. It also shows the difference between US and European employment rates. The figure shows that although Europe started out at higher employment rates, the difference turned positive around 1970 and kept on increasing until the beginning of this decade. The graph also shows that the differences are largest for women.

[42] See Disney (2000).

[43] See Fitoussi (2000) and the references therein.

- Although European employment rates already started to decrease relative to US employment rates before the seventies, the decrease accelerated after 1970. In Figure 5 this is only visible in the employment series for men, but that is because in Italy employment rates deteriorated sharply before 1970. Figure 6 reports changes in employment rates for the U.S. and several European countries. This figure documents that for several European countries including France and Germany there is evidence of an acceleration in the decrease in European employment rates in the 1970s.

This raises two questions. The first is why the relative deterioration in European employment rates before 1970 did not show up in increases in unemployment rates. To address this issue would require a model that also incorporates a decision to be in the labor force, which is beyond the scope of this paper.[44] The second question is what explains the deterioration of employment rates before the seventies and in particular whether this empirical observation is consistent with the framework developed here. We turn to answering this question now.

Since European employment rates started out being higher than US employment rates, one possibility is that the reduction in European employment rates before 1970 was simply due to transition dynamics. Another reason, and this one would be consistent with the framework developed here, is that the reduction is due to increases in tax rates. The focus in this paper is on endogenous changes in tax rates that are caused by changes in the unemployment rates. However, changes in tax rates for other reasons, such as increases in government expenditures, would also lead to an increase in unemployment rates. Figure 2 shows that indeed European tax rates already increase before 1970. However, the figure also shows that US tax rates increased and that the difference in tax rates was fairly constant. But the analysis in this paper stresses that it is unlikely that the effect of tax rates is linear and that changes in tax rates have similar effects at different levels. The effect of tax rates is larger when the mass of jobs just above the cutoff level is higher. Arguably, we would expect this mass to be higher in Europe, because (i) the value of the outside option is larger in Europe and (ii) the initial level of tax rates is higher.

9 Concluding comments

This paper provides a theoretical argument for the possibility that relatively small changes in tax rates have large effects on the unemployment rate. It would be in-

[44] One possibility is that in the sixties there were still enough attractive opportunities outside the labor force (child care, education, etc.), but that as employment rates dropped the number of people for whom these were attractive opportunities decreased sharply.

teresting to extend the framework here and model the effect of tax rates on growth rates along the lines used in, for example, Daveri and Tabellini (2000) or Novales and Ruiz (2002). But the simple structure made it easy to lay out the essential mechanisms driving the results. Key in obtaining the result that tax rates have a large effect is the focus on the extensive margin and the condition that the mass of jobs close to the cutoff level is large. To determine whether this condition is empirically valid would not only require data for the surplus of existing jobs, but also for jobs that do not exist because the corresponding surplus value is negative. Obviously, this data would be difficult to obtain, although with surveys useful data might be collected.[45] This type of data would be very useful to understand differences across European countries. The analysis here makes clear that countries that have a different number of jobs with low surplus value will have a different response to changes in the tax rate.

With such data it would be interesting to look at how the distribution differs across countries and time (and in particular whether the fraction of jobs "at risk" differs). But it also would be interesting to see how the fraction of low-surplus jobs differs by sex. When we look at differences between European and US unemployment rates, then gender matters a lot. This is made clear in Figure 7 that plots the European unemployment rate relative to the US unemployment rate by sex. The Figure shows that before 1970 the difference between the European and US unemployment rate varied across time but that the difference was identical independent of whether one looked at unemployment rate for males or females. After 1970, however, the relative deterioration of the European employment situation is mainly due to an increase in the unemployment rate for females. This result together with the results in Figure 5 for employment rates leads one to believe that a big difference between European and US labor markets is how those markets have responded to the increase in female labor force participation. Whereas the U.S. has been successful in increasing the employment rate for women, in Europe part of the increase in female labor force participation has resulted in higher unemployment rates. It would be worthwhile to investigate whether this phenomenon is related to the finding in Rogerson (2003) that the difference in European and US employment rates is due to the ability of the U.S. to replace the jobs that are destroyed in the declining manufacturing sector by jobs in the expanding service sector.

[45] Note that, for example, cross-sectional data on wages ignores other forms of value added as well as the outside option of the worker, the capital used, and the entrepreneur.

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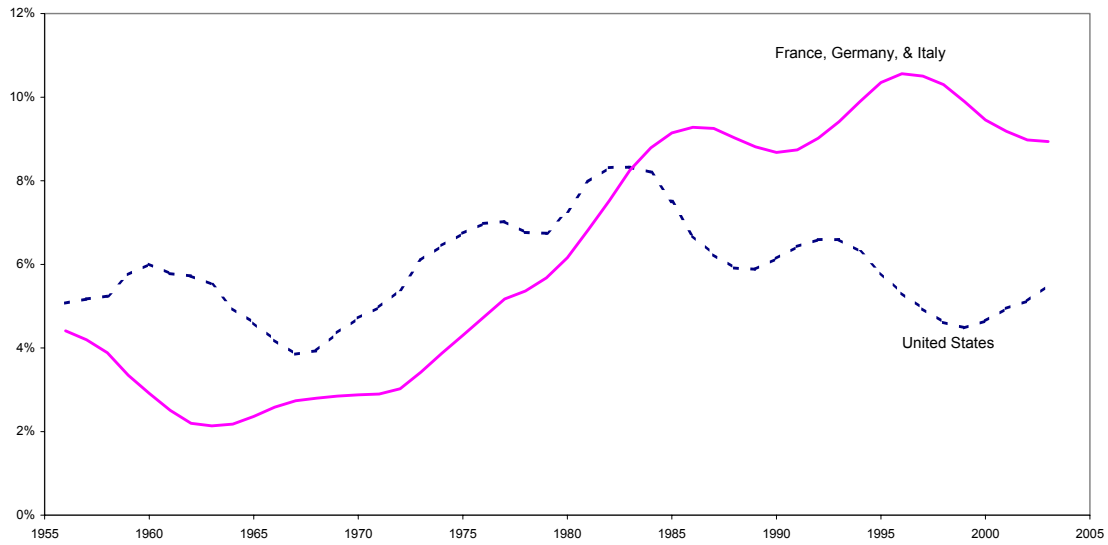
Figure 1: Unemployment rates

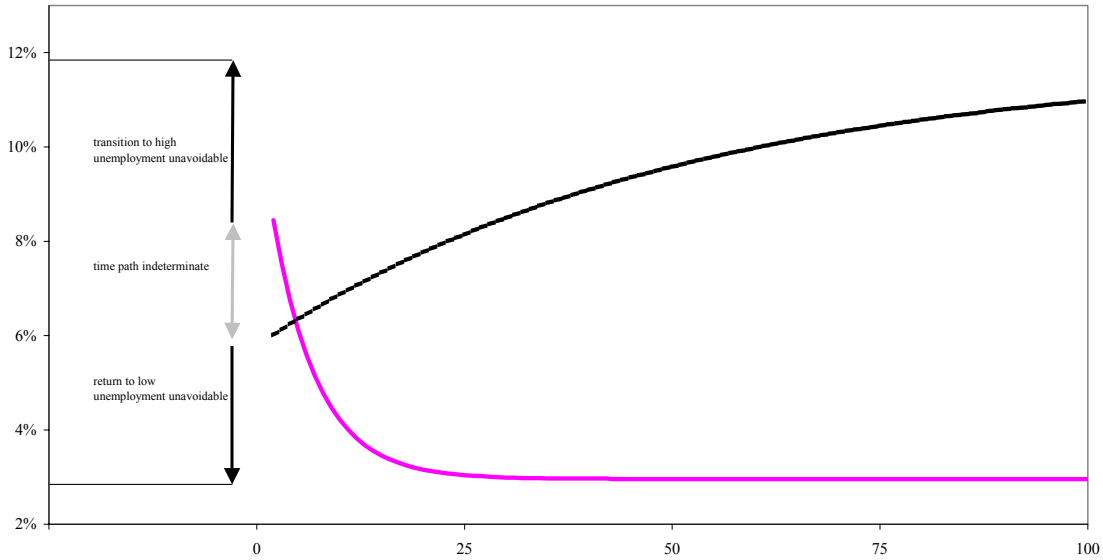


Notes: This figure plots unemployment rates for the indicated countries. The series are smoothed using a two-sided moving average. The European data are calculated as the ratio of the total number of employed workers in the three countries to total number of persons in the labor force in the three countries. Starting in 1991 the data for Germany incorporate the former Deutsche Demokratische Republik (DDR). The data are from the Labor Market Statistics of the OECD (Corporate Data Environment).

Figure 2: Government Outlays as percentage of GDP

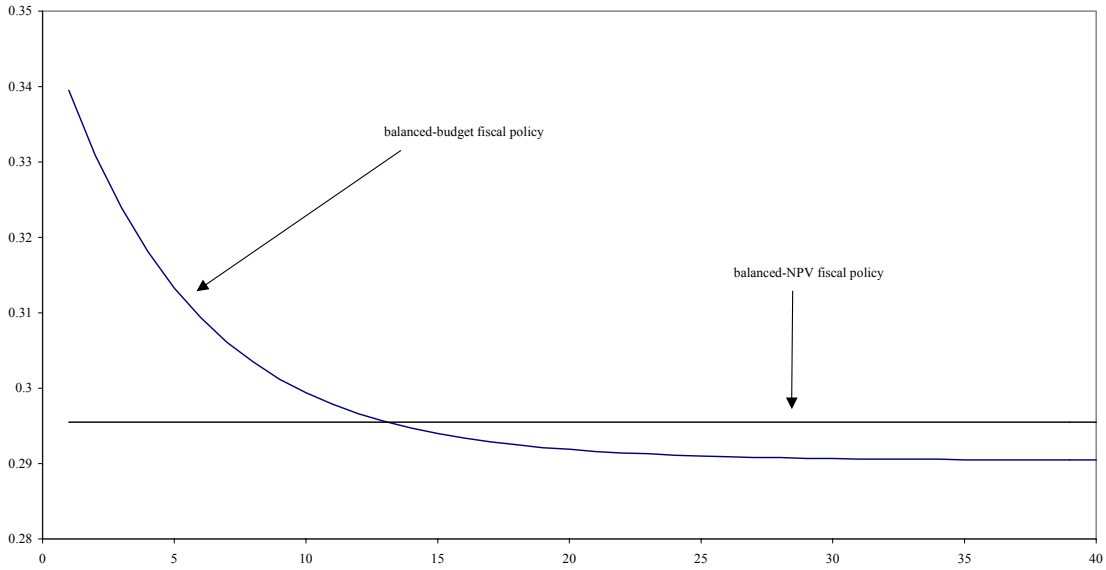
Notes: Total outlays exclude consumption of fixed capital. Data are from the OECD (national accounts in SourceOECD).

Figure 3: Unemployment rates after a one-time burst in job destructions



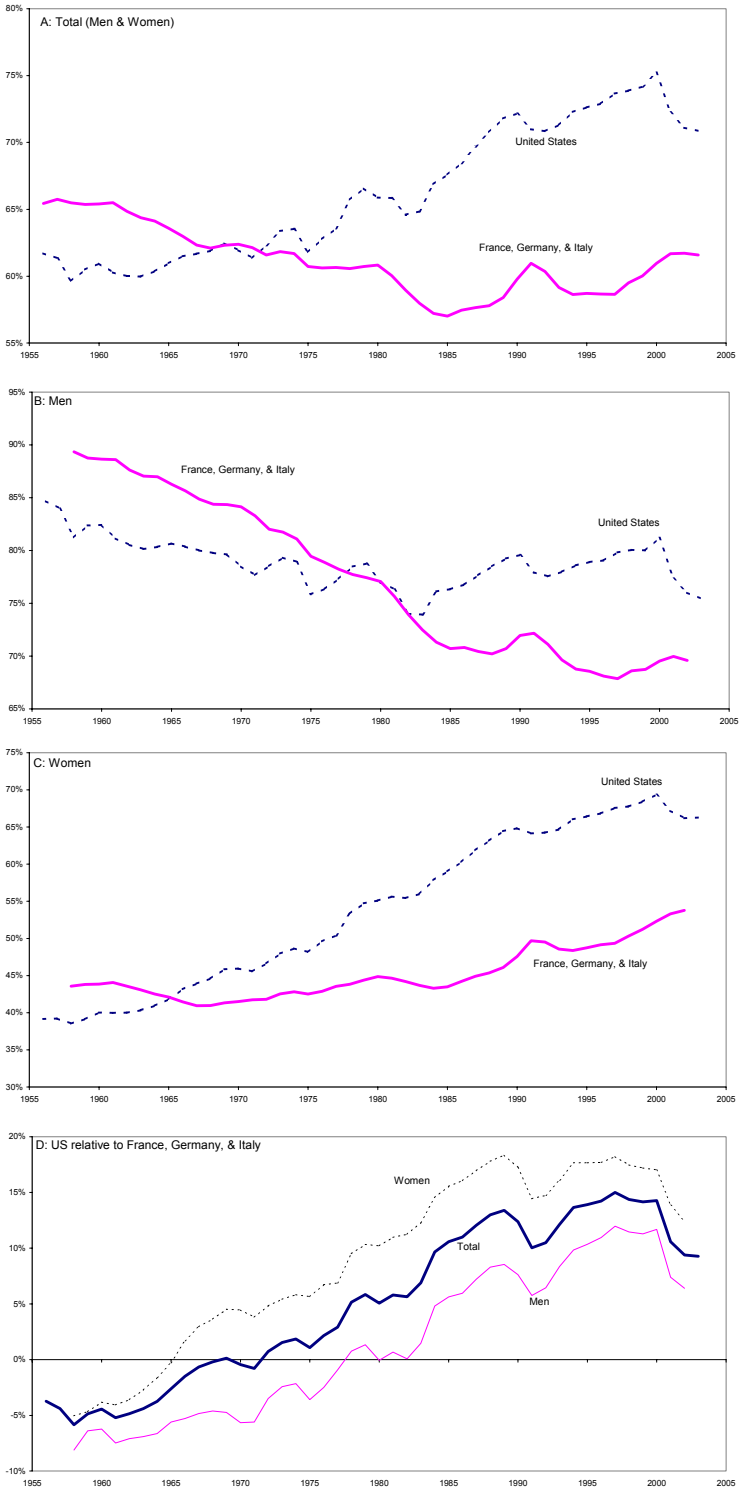
Notes: The parameters for this case are given in the second column of Table 2.

Figure 4: Tax rates under balanced-budget and balanced-NPV fiscal policy



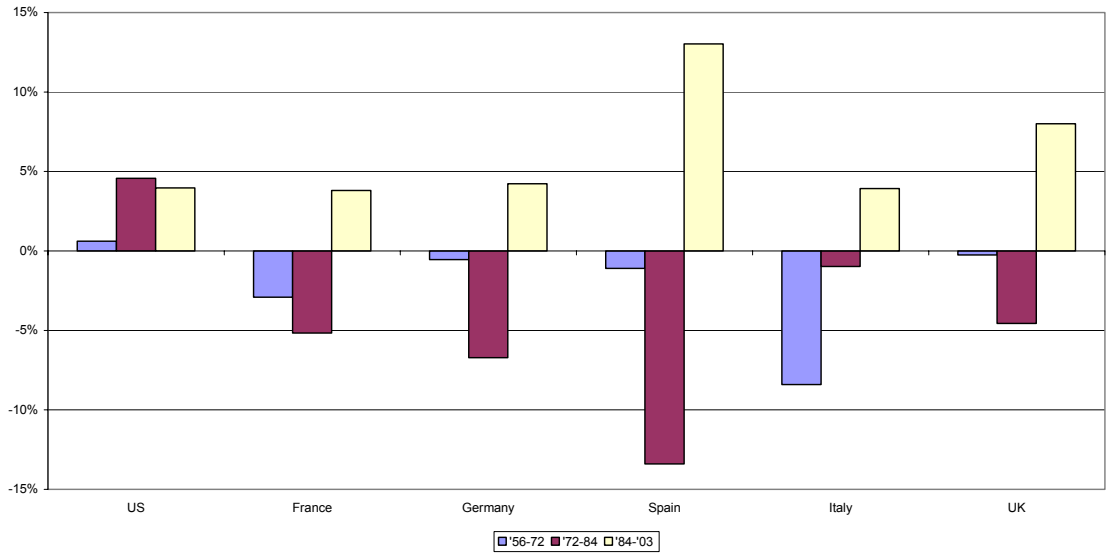
Notes: The parameters for this case are given in the first column of Table 2.

Figure 5: Employment Ratios



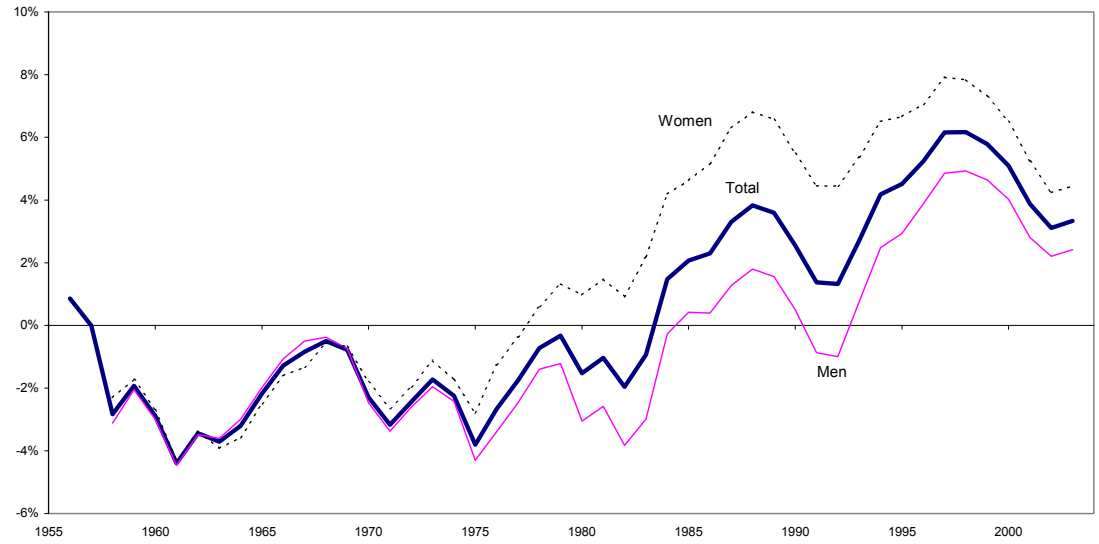
Notes: The employment ratio is calculated as the ratio of civilian employment to the population aged 15 to 64. For the European series the ratio is calculated as the sum of the employed in the three countries relative to the sum of the working age population. The data are from the Labour Market Statistics of the OECD (Corporate Data Environment).

Figure 6: Change in Employment Ratios
(% points)



Notes: This figure plots the change in the employment ratio (civilian employment to working age population) over the indicated time period. The data are from the Labour Market Statistics of the OECD (Corporate Data Environment).

Figure 7: European unemployment rates relative to the US by sex
(% points)



Notes: This figure plots the difference between the unemployment rate in the region consisting of France, Germany, and Italy and the US unemployment rate. The European series are calculated as the ratio of the total employed in the three countries to total labor force in the three countries. The data are from the Labor Market Statistics of the OECD (Corporate Data Environment).

Table 1: Effective tax rates on labor income and unemployment benefits
(percentages; 1961-91 average)

Country	labor income	unemployment subsidies	difference
Belgium	39.2	27.3	11.9
France	39.8	31.0	8.8
Germany	36.3	8.0	28.3
Italy	34.0	-4.4	38.4
Netherlands	44.6	29.7	14.9
Norway	37.0	20.8	16.2
Spain	24.8	16.2	8.6
Sweden	42.2	15.8	26.4
U.K.	24.2	1.2	22.9
Europe (average)	35.8	16.2	18.0
U.S.	24.1	0.8	23.3

Note: These numbers are from Table 3 in Daveri and Tabellini (2000).

Table 2: Parameter Values

	I	II	III
	$z_{l,1} = z_{l,2}$	$z_{l,1} < z_{l,2}$	$z_{l,1} << z_{l,2}$
β	0.99	0.94	0.98
b	0.265	0.267	0.0
r	0.5	0.5	0.29
z_l	1.0	-	-
$z_{l,1}$	-	1.0	0.0
$z_{l,2}$	-	1.075	1.26
z_h	1.2	1.2	1.3
ρ_l^x	0.01	0.01	0.0
ρ_h^x	0.0	0.0	0.0
ρ^r	0.01	0.01	0.05
$p^n(z_{l,1})$	-	1.0	1.0
$p(z_{l,2}\|z_{l,1})$	-	0.04	0.01
$p(z_{l,1}\|z_{l,2})$	-	0.0	0.0
λ_l	0.15	0.15	0.5
λ_h	0.5	0.5	0.5
ϕ	0.9	0.9	0.9
ψ	0.4	0.4	0.4
gov	0.32	0.32	0.32

Table 3: 1994/1995 Net replacement rates

Country	Net Replacement Rate
Belgium	59
Denmark	81
Italy	19
Netherlands	69
Norway	62
Spain	49
Sweden	67
U.K.	51
U.S.	16

Note: The values are from Table 2 in Martin (1996) and represent an overall average across beneficiaries with different family circumstances for the first five years of unemployment. They are expressed as a percentage of the pre-displacement wage.

Table 4: Steady-state properties

	low-unemployment steady state	high-unemployment steady state
unemployment rate	3.0%	11.8%
tax rate	29.6%	35.0%
total transfers / output	1.1%	4.8%

Note: This table reports the steady-state properties when the parameter values are equal to those in the first column of Table 1. Unemployment rates for the parameter set in the second column are identical to those reported here. The same is true for the tax rate in the high-unemployment steady state, when nobody operates at either $z_{l,1}$ or $z_{l,2}$. In the low-unemployment steady state the tax rate is equal to 28.9%. The different value for exogenous breakups in the third column implies somewhat lower unemployment and tax rates.

Table 5: Overall tax burden as a percentage of GDP

	1966-70	1971-75	1976-82
Austria	24.6	26.9	29.9
Belgium	34.6	38.6	44.8
Denmark	35.5	42.9	43.7
Finland	32.0	34.4	37.1
France	35.4	36.0	41.2
Germany	32.7	35.4	37.1
Greece	23.7	24.2	28.6
Ireland	29.4	31.6	35.7
Italy	28.0	28.2	33.6
Luxembourg	30.0	34.0	39.9
Netherlands	36.7	41.5	44.7
Norway	37.4	44.4	47.0
Portugal	20.5	22.9	28.3
Spain	16.3	18.5	23.1
Sweden	39.0	42.4	50.0
Switzerland	22.6	26.1	31.1
U.K.	34.6	34.3	35.7
Europe (average)	30.2	33.1	37.1
U.S.	28.3	29.2	30.1

Note: These values are from Table 56 in Saunders and Klau (1985).

Table 6: Transfers to the working-age population in 1992

Country	Unemployment Compensation	Total Transfer
Belgium	2.2	8.7
Denmark	3.6	11.9
France	1.6	7.0
Germany	1.5	6.0
Ireland	3.2	7.9
Italy	0.7	3.7
Netherlands	2.8	12.7
Norway	1.4	9.9
Spain	3.2	6.7
Sweden	2.6	11.7
U.K.	1.2	8.1
U.S.	0.7	3.2

Note: Values are from Tables 1 and 2 in MacFarlan and Oxley (1996) and are expressed as percentage of GDP.

Table 7: *Change in ratio of unemployment compensation to GDP*, 1970-1981

Denmark	12.1
France	5.93
Germany	4.48
Ireland	1.91
Italy	3.62
Norway	3.2
Sweden	1.95
United Kingdom	2.92
Europe (average)	4.51
United States	1.26

Note: These numbers are from Table 35 in Saunders and Klau (1985). In addition to the U.S., only those European countries are included for which data are based on the complete sample.