Transitions in the German Labor Market: Structure and Crisis*

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Abstract

This paper quantitatively assesses the role of structural and cylical policies on the adjustment of the German labor market. We develop a heterogeneous agent search and matching model in the spirit of Ljungqvist and Sargent (2004) with workers stochastically accumulating skills on the job, and decumulating skills when unemployment. To this we add a stylized representation of German labor market legislation. Earnings-dependent unemployment insurance benefits and social welfare assistance are calibrated to match the German labor market structure before and after the so-called Hartz IV reforms in 2005. The main aspect of these reforms was a significant reduction in the duration of benefit entitlements. The model generates a reduction in unemployment and unemployment duration close to the changes observed since 2006. During the global economic crisis of 2008 and 2009, the German government extended the use of short-time labor subsidies to prevents jobs from being destroyed. We find that such policies can avoid the strong increases in unemployment that has taken place in other countries.

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1 Introduction

This paper is about the structural transition of the formerly rigid German labor market to a more competitive one, after substantial reforms adopted around 2005, and about the cyclical transitions in the German labor market after the global economic crisis of 2008 and 2009. While many countries (such as the U.S. and Spain) were stuck with high unemployment two years after the low point of the recession, Germany's unemployment had barely fallen during the crisis and the economy has rebound to an extent that there are even reports of shortages for skilled labor. Some observers even speak of a German employment miracle. It is not clear however, whether this performance is due to the reforms, the particular policies adopted during the crisis, such as short-time labor subsidies, or just a lucky combination of shocks, as has also been argued.

We develop a quantitative general equilibrium labor market search and matching model to address these issues. The driver of labor market flows in the model are stochastic variations in the productivity of individual worker-job matches, which determine separation and job acceptance rates. The key feature is the dynamics of individual workers' skills on and off the job, and unemployment benefits that depend on previously earned wages. Ljungqvist and Sargent (2004) have shown that these elements are crucial to explain the hysteresis in European labor markets that arose during the 1980s. The two interact by raising reservation wages for workers whose skills have depreciated since job loss but whose benefits are high. The main difference between their model and ours are the institutional details that allows mimicking the situation of the German labor market before and after the reforms, a stylized analysis of aggregate shocks, and the analysis of a labor market subsidy applied to stabilize employment after adverse shocks.

Our simulations show first how the German labor market reforms affected labor market flows, unemployment, and the distribution of skills and benefit entitlements. The original unemployment insurance system consisted of earnings-

dependent entitlements of very high duration. This reduced job search and job acceptance incentives. The reform significantly reduced the duration of benefits to about a year, after which all workers' benefits fall to an exogenously given welfare entitlement. We find that the new system may be responsible for a drop in the unemployment rate of about 3 percentage points (from 10.5 percent in 2005), mainly due to an increase in outflow rates from unemployment, in particular for those who most recently lost their jobs. General equilibrium feedback effects add to the induced higher job acceptance rates, since firms' incentives to create jobs rise, and a tighter labor market works to offset the initially weakened bargaining position of workers.

We then turn to transitions after aggregate shocks. This is interesting because, on the one hand, the German reforms may have changed the manner to which the economy responds to shocks. Also, it may be that shocks, rather than reforms, that are in fact responsible for the drop in German unemployment. On the other hand, to analyse the role of labor market policies during the crisis of 2008 and 2009, we need to ascertain which shocks best represent its causes. We treat shocks as permanent changes in aggregate variables, such as aggregate productivity, labor matching efficiency, and the discount factor, and compare the adjustment of the labor market for a stylized short-run and a long-run scenario. Particularly, the discount factor shock may be seen as a proxy for the financial turmoil which raised interest rates for firms and households alike. It turns out that the labor market is highly sensitive to even moderate changes in the discount rate. A less than one percentage point increase in the discount rate can raise unemployment by more than 4 percentage points, which have strong effects on the unemployment rate. In contrast, a five percent drop in aggregate productivity has comparatively modest effects on the labor market. A fall in matching efficiency by ten percent has also only moderate effects.

The question to ask is whether labor market policies can mitigate the response to such aggregate shocks? Rather than providing a full-fledged welfare based analy-

sis, we investigate and contrast two important policies that have been implemented. First, we analyse the labor subsidy that was offered to firms during the crisis in Germany and other European countries. Mostly, this takes the form of a short-time labor allowance, helping firms to cut labor cost while protecting incomes. We model such subsidies as a transfer payment to job-worker matches that would otherwise separate after a drop in profits. We find that labor subsidies can indeed help reduce the labor market impact of temporary slumps.

We then contrast the labor subsidy to a temporary increase in the duration of unemployment benefits as implemented in the U.S. and a few other countries. Potentially, a higher duration of benefits reduces incentives to accept a new job at a time when the likelihood of finding a job is the lowest.[1] We calibrate the model to the – much lower – U.S. benefit levels and duration, and find that this policy has only moderate influence on the unemployment rate. Even the emergency unemployment package with allow benefits to be received for up to 99 weeks, the unemployment rate rises by less than a percentage point. It can certainly not explain the increase in the U.S. unemployment rate from below 6 to about 10 percent.

Our paper is most closely related to the contributions of Ljungqvist and Sargent (2004 and 2007) and Nie (2010). In a series of papers, Ljunqvist and Sargent develop models that explain the rising European unemployment as an outcome of increased skill obsolesence upon job loss, which they call 'turbulence'. In contrast, the U.S. labor market, which has low unemployment benefits of short duration, is argued to be able to respond flexibly to higher turbulence. In their 2007 paper, the authors have shown the robustness of their results to the inclusion of matching frictions and firing costs. Nie (2010) uses similar model to focus on the German labor market reforms and their effects on the incentives to accumulation human capital through training, but keeps the assumption of a constant matching rate,

[1] Of course there may be other factors at work, which affect search incentives, such as increased mobility cost because of the housing market slump, but analysing these is beyond the scope of the paper.

as in Ljungqvist and Sargent (2004), which, in constrast, we endogenize. Furthermore, the other papers do not consider policies that affects the responses of the labor market to shocks.

The paper proceeds from here as follows. In the next section, we give some institutional background on the German labor market, and on the changes brought about by the reforms. We also discuss the short-time labor subsidy used extensively during the crisis, and explain which aspect of it we deem most relevant for our analysis. In section 3 we set up the model in detail, and discuss our calibration strategy. Section 4 presents the results. First, we illustrate the workings of the model by simulating the reforms of the German labor market. We show the transitional dynamics of employment and unemployment rates by skill level and benefit entitlements. Secondly, subject the model economy to a number of shocks, identifying the shocks that may have caused the recession, or at least best represent its labor market repercussions. Third, we introduce a labor subsidy scheme and assess its role for stabilizing German employment during the crisis. Finally, we contrast this to an increase in the duration of unemployment entitlements. Section 5 concludes.

2 Background and data

The relevant facts concerning this paper are the evolution of the German labor market from before the Hartz IV labor market reforms, such as the unemployment rate, unemployment duration. Then, to understand this evolution, a closer look at the institutional setup before and after the crisis needs to be taken. And finally, it is necessary to document the scope of the German short-time work subsidy system, and its role during the crisis. This section in turn takes up these aspects.

2.1 Long-term evolution of the German labor market

Since the 1980s, the German labor market experienced ever-increasing unemployment, rising from about 4 percent to about 10%, when the labor market reforms implemented in 2005. Similar developments have taken place in other continental European economies. Figure 1 shows the evilution fo the German unemployment rate since 1980. Notable is the increae in the early 1980s, then a decline since 1989 (the 'reunification boom'), and then an increase until 2005, interrupted by the dotcom-bubble around 2000. Since 2005, the unemployment rate has fallen persistently until the 2008/2009 global economic crisis, where it barely increased.

Figure 1: German unemployment rate since 1980, ILO definition

2.2 The institutional background

The most recent labor maket reforms in Germany were enacted in a sequence of steps from 2002, until on January 1, 2006, the final step, called Hartz IV, was implemented to change the benefit system. The first steps were largely concerned with reforming the Federal Employment Agency, as well as developing better tools

for improving search and retraining, and measures to foster self-employment.[2] The last step was key, as it reduced in the duration of the entitlement to earnings-dependent unemployment insurance.

Before Hartz IV, the German unemployment benefit system consisted of *three* components: unemployment insurance benefits, unemployment 'assistance', and supplementary social assistance. Unemployment benefits were (and are) part of the compulsory social security system, and are thus financed through a tax on labor, paid in half by employees and employers. The incomes support from that system typically lasted 52 weeks.

The second component, unemployment assistance, was the most distinct feature of the German welfare system, and has been entirely removed with the reforms. Its 'assistance' payments were based on previous net earning, albeit at a lower percentage than unemployment benefits, and after means testing, but the duration was indefinite. Particularly workers with relatively high earnings before unemployment, but low or depreciated marketable skills, had little incentive to search for jobs and were thus likely to stay long in unemployment assistance. Many of these workers eventually entered early retirement without ever having participated in the labor market again.

Social assistance was also means-tested and paid an indefinite amount of time, but it did not depend on previous employment or earnings. It was mainly meant for non-employable persons, but unemployed workers could receive supplementary payments from social assistance when their benefit income was below a specified existence minimum. Also the number of children was taken into account and subsidies may have been paid for accomodation.

The key innovation of the Hartz IV reforms was to merge unemployment assistance and social assistance, essentially abolishing the former. The now newly defined "unemployed income II" (for Arbeitslosengeld II, henceforth ALG II) is

[2] See Ebbinghaus and Eichhorst (2009), Goede (2006), and Eichhorst and Marx (2011) for a detailed description of German labor market policies.

a means-tested payment which depends on basic needs, family status, and willingness to work. It thus is much closer to the previous social (welfare) assistance than to the unemployment assistance. Refusal to work may lead to cuts in the benefit level, at the discretion of local employment agencies. Notably, a person is employable if he or she is capable of working at least three hours a day. It can also be paid to employed persons or those on what is now called ALG I, whose income is below a certain level. The design of ALG I remained largely unchanged from the former unemployment benefits, and is based on previous earnings, but paid for about one year only.[3]

In spite of these – for Germany – rather fundamental changes, the new system carries in it some exceptions that may reduce its effectiveness. For example, a supplementary temporary benefit is paid after transiting into ALG II, for up to two years. This mitigates the incentives to start searching for jobs early during an unemployment spell. Further, in ALG II, additional support is granted for housing and heating, and it depends on the number of dependents. Thus most affected by the changes are those un-married and able to work.

Several empirical studies focus on the incentive problems in the German unemployment benefit system.[4] Ochel (2005) finds that high unemployment benefits result in higher reservation wages and, therefore, adversely affect the transition from unemployment to employment. Schäfer (2003) concludes that the evidence shows that the duration of unemployment benefits is largely responsible for increases in unemployment duration.[5] However, the effect of the replacement ratio appears muted. Correspondingly, Christensen (2005) finds that higher reservation wages lead to a higher unemployment duration. According to OECD (2006), the German unemployment insurance system still provides disincentives for labor supply. Especially a lower level of support for the low-skilled would increase the transition to employment.

[3] Workers above 55 years of age have an entitlement to 18 months of ALG I.

[4] See, for examples, Ochel (2005), Nickell et al. (2005), Breyer et al., Sinn et al.

[5] See also Goede, p.26.

2.3 Labor market stabilization

During an economic downswing, a number of demand stabilization policies and social policies are often used to reduce the impact on output and employment, or on the burden of increased joblessness. Many countries employed demand management measures during the crisis, expanding government spending, reducing taxes, or more direct measures such has cash payouts or subsidies to purchase certain durable goods, such as cars. Here, we focus on two policies directly affecting the labor market, namely short-time work subsidies and extensions of unemployment insurance benefits. While the former is a demand policy aimed directly at stabilizing employment, the latter is targeted at workers that have become unemployed, but whose chances of finding new employment are deemed exceptionally low while the downswing lasts. It is thus more a social policy with potential consequences for labor supply incentives.

2.3.1 Short-time work subsidies

A stunning feature of the evolution of the German labor market during the crisis is the absence of a significant increase in unemployment, as visible in Figure 1. At the same time, output fell in 2009 by 4.7 percent. Correspondingly, labor productivity sharply declinced. Also job openings fell only by a quarter during the crisis and have returned now to pre-crisis levels. This is in stark contrast to the U.S. experience, where unemployment almost doubled, while productivity increased. So the question is why many German employers chose to keep most of their workers? A tool used by the German government to stabilize employment is a short-time work allowance, which allows firms to cut hours worked and reduce monthly wage payments to workers. The government matches part of the gap between the regular monthly pay of its workers, and the reduced pay under short-time work. Figure 2 show the numbers of workers affected by short-time work

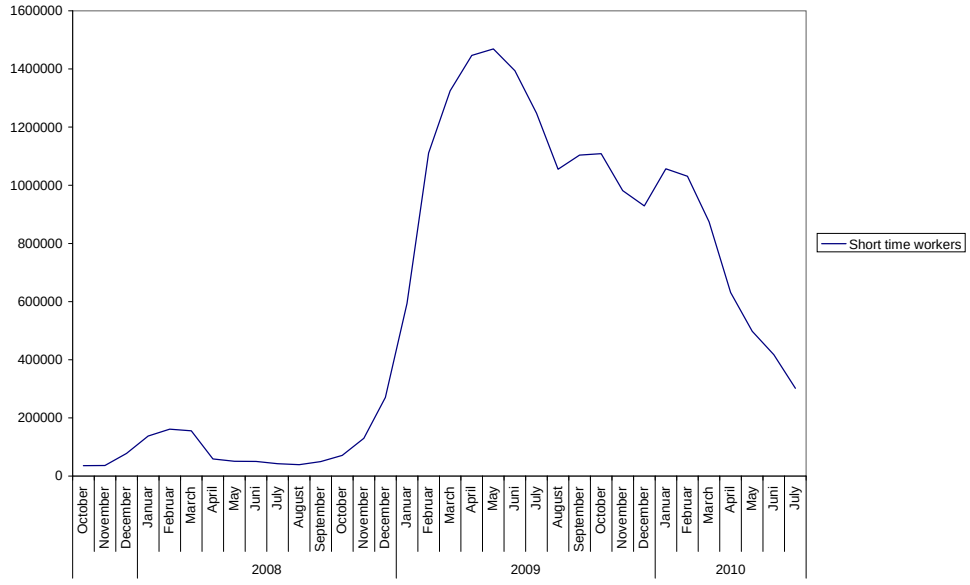

Figure 2: Workers affected by government sponsored short-time work arrangements, October 2007 - July 2010

allowances, which reached a peak of almost 1.5 millon in May 2009.[6]

The short-time work subsidy is in normal times paid up to six month. Essentially, firms are eligible if the reduction in work-time is due to economic circumstances or unavoidable events, if it is temporary, and cannot be avoided. A minimum requirement is that the reduction in work-time would lead to a loss of at least 10 percent of monthly earnings, and at least a third of the employees must be affected. In the crisis, there have been successive extensions by ordinance. First, in 2009, the duration of the eligibility was increased to 24 months (for applications until 31. December 2009. At the end of 2009, the duration was set at 18 months for new applications, and fiannly, for 2011, and extension to 12 months above the standard 6 months was decided. Under such circumstances, the German Labor Agency pays at least 60 percent of the gap between normal pay, and the pay under reduced work time. Furthermore, at least part of the social security contributions

[6]For more details on short-term labor allowances in Europe during the crisis, see European Commission (2010).

regularly paid by the employer are reimbursed. From July 2009, 100 percent of social security contributions were paid to employers.[7]

2.3.2 Increased duration of unemployment benefits

Some countries also respond to exceptional labor market conditions by extending the maximum entitlement period for unemployment benefits. Examples are France and Ireland, but most notably the U.S. No country chooses to pay higher benefits in a recession.[8] During times of exceptionally high unemployment, the U.S. government often extends the normal eligibility period for unemployment benefits of 26 weeks by 13 weeks. Some states offer 7 additional weeks during periods of extremely high unemployment.[9] In the current crisis, the federal administration has introduced an Emergency Unemployment Compensation (EUC) which in the most recent modification increased the eligibitity period to 99 weeks. After expiration, Americans are of course eligible to a number of in kind benefits and welfare payments. The replacement rate in the U.S. is about 47 percent on average, even though states replace 50 of pre-tax wage income. Some fraction of benefits is tax-exempt.

3 The model

Our model specifies the labor market as consisting of workers that search for jobs, and jobs that search for workers, mediated by a matching function that generates individual contacts between these two groups. The finding probabilities depend on the relative quantities of searching jobs and workers. Upon contact, the pair observes an initial idiosyncratic productivity of their match. If the productivity is above a critical threshold, they begin an employment relationship and start pro-

[7] One may be tempted to ask why such subsidy is necessary when workers and firms are free to privately agree on cutting wages to save the jobs.

[8] Again, for more details, see European Kommission (2010).

[9] See the United States Department of Labor webite http://workforce.security.doleta.gov /unemploy/extendben.asp.

ducing, and share the proceeds of their match according to a bargaining protocol. Otherwise, the match is not consummated, and the two parties keep searching. Productivity occasionally changes so that later separations may take place endogenously.

Whether joint production is profitable and how it is shared depends the specific characteristics of the worker and on the parties' outside options. We assume that workers are heterogeneous along two dimensions: skills and unemployment benefit entitlements. Workers can be unskilled or skilled depending on experience on the job. Jobs with skilled workers are more productive and therefore are profitable even for idiosyncratic productivities at which low skilled matches would never form or would separate. While employed, workers may receive a skill upgrade, while unemployed, their skill depreciates, both at given rates.[10] After job loss, workers initially receive unemployment insurance benefits that depend on previous income. After expiration of the insurance entitlement a lower welfare benefit is received.

Skill and benefit entitlement, as well as general labor market conditions determine a worker's bargaining position and thus also the chances of a match forming. What matters during bargaining is a worker's expected income if he or she falls back into unemployment, which depends on benefit entitlement and job finding probabilities. For example, when unemployment is high relative to the number of vacant jobs, chances of finding a job are low, and thus a negotiated wage will turn out low. Similarly, if a benefit potentially received if unemployed is low, a negotiated wage will tend to be low. Also firms' bargaining position depends on labor market conditions. When jobs and workers contact, these factors determine the critical threshold for the idiosyncratic produtivity below which the job match would not generate enough surplus to cover both parties' outside options.

In the next subsection, we describe the details of the model, specifying the exact determinants of skill transitions and unemployment benefits entitlement changes,

[10] Skills are general in the sense that they a transferable across jobs, but they can only be build up through work experience, not through training. See Nie (2010) for a Ljungqvist-Sargent type model with training.

the dynamics of productivity changes and worker flows, preference parameters, and assumptions on the government. Then we derive the equation necessary to solve the model, namely the present values that guide agents' decisions, as well as wage equations, and the details on the government budget balance.

3.1 General setup

Time is discrete and there are two types of agents, workers, firms that consist of one job each, and a government. Workers can either be employed or unemployed, and jobs can be vacant or filled with a worker. At each point in time, workers have one of several possible levels of general human capital, or skill, indexed by quality $i = 1, ..., I$, with $i = 1$ being the highest quality. Employed workers with $i > 1$ receive stochastically arriving skill upgrades (repsenting, for example, learning-by-doing), which arrive at a constant Poisson rate. For each skill class, jobs produce output with productivity drawn from a distribution, $z \sim \nu_i(dz)$, whose first moment depends on the skill-level i. A job-worker pair produces total output $y = z$. New draws for z arrive with probability γ^s, which thus governs the persistence of idiosyncratic shocks.

Unemployed workers receive unemployment benefits, with one of several possible levels b_j, indexed $j = 1, ...J$, falling in j. The benefit of workers separated from their jobs depends on previously earned wages. Unemployed workers experience benefit reductions that arrive stochastically according to a rate chosen to match on average the duration of the benefit entitlement. This represents the termination of one type of unemployment benefit for another. When unemployed, workers with skill higher than the minimum skill may suffer loss in skill, which also arrives stochastically, at a given arrival rate. A constant fraction of existing jobs is exogenously destroyed each period, while the remainder is destroyed endogenously. This may happen if either a new draw of z or an increase in benefit entitlements renders continuation of the match inefficient. Note that a threshold exists for each skill group and the benefit level that workers would receive if he or she were to

become unemployed.

Transitions between unemployment and employment are endogenous. Workers have contact with job opportunities at the arrival rate $\lambda^w = m(v,u)/u$, which is governed by a constant-returns matching function $m(v,u)$ that depends the number of job vacancies v and unemployed workers u. For firms, the probabilities of finding workers with skill-benefit mix i,j depend on the relative masses of the different unemployed worker types, and are:

$$\lambda^f(i,j) = \lambda^f \frac{u(i,j)}{u}.$$

where $\lambda^f = m(v,u)/v$, and $u(i,j)$ is the measure of workers with skill level i, and benefit entitlement j. Note that search is not directed but random, that is, firms cannot target vacancies at a particular type of worker. Instead, they post vacancies on the basis of the skills and entitlements of the average worker they may contact. After a contact with a vacant job, the rate at which matches are formed (and workers accept a job match) depends on the idiosyncratic productivity draw z for that job. Matches with draws below a critical threshold are not consummated, and firm and worker continue searching.

Worker and firm are assumed to bargain over the surplus of the match, with a share π going to the worker and the share $(1-\pi)$ going to the firm. While the worker's fallback option in wage negotiations depends on his benefit entitlement and current skill, the firm's fallback is assumed to be given by an entry cost V_f. We assume that workers have linear utility in consumption, and discount future income with a constant factor β. Assuming perfect capital markets, firms use the same factor when discounting profits.

Output z is taxed at a proportional rate τ, so that net output $(1-\tau)z$ remains for the match to share. The government's expenses for the welfare state are the benefit payments to the various types of unemployed workers, wheras taxes are levied on all existing matches. Since the cost of the welfare state is only a fraction of a government's budget, we assume that there is an exogenous expenditure com-

ponent. Then tax rates can have realistic magnitudes, rather than just covering welfare payments. The exact transition probabilities are specified below, in the calibration section.

To summarize, a worker can be in one of $I \times J$ states (i, j). Transitions between the states are probabilitistic and Markov. Given the current state (i, j), the transition to a new state (i', j') for an unemployed worker is given by the probability $P(i', j'; i, j)$. For an employed worker, the state is also described by a pair (i, j) of current skill and entitlements if he were to become unemployment, which may change with length of employment. For active matches with employed workers, we need to distinguish three events, denoted by an indicator $n = 1, 2, 3$. When $n = 1$, there was not change in z, and the match remains active. When $n = 2$, a new draw for z was taken, but it did not lead to a separation. Finally, when $n = 3$, there was an exogenous or endogenous separation. The latter will have occured either because of a rising entitlement (even for unchanged z) or because of a change of z below a critical threshold, so that the match is not worth continuing. Therefore, $Q(i', j', n'; i, j)$ denotes the probability for an employed worker in current state (i, j) to transit to the new state (i', j') given the circumstances indicated by n'.

3.2 Present values

The decisions of workers and firms are guided by discounted present value considerations. As decribed, the decision problems of workers are to accept or quit a job, contingent on her current skill level i, the current unemployment benefit entitlement j, and the current job-specific productivity z. Firms choices are to enter the matching market and to decide whether to separate from a worker.[11] During unemployment all workers search, but matches are only accepted if the idiosyncratic productivity draw is such that the present value of employment exceeds that of

[11] Separations are efficient, so firms and workers always agree when the match is dissolved. Thus quits and layoffs cannot be distinguished from this perspective. Nevertheless, we define all separations as involuntary, leading to a loss of skills.

unemployment. The surplus from a job producing with productivity z is given by

$$S(i,j,z) = (1-\tau)z + G(i,j,z) - V_f - b_j - V(i,j)$$

where $(1-\tau)z + G(i,j,z)$ is the sum of the flow product net (of taxes) and the present value of the job, and $-V_f - b_j - V(i,j)$ is the sum of the outside options of worker and firm. $V(i,j)$ is the present value of unemployment to the worker. This surplus is the pie available to be shared by firm and worker.

The continuation value G of the match depends on changes in the exogenous and endogenous states that occur from one period to the next, and is given by

$$\begin{aligned} G(i,j,z) &= \beta \sum_{i',j'} Q(i',j',1;i,j) \left[\max\{S(i',j',z),0\}\right] \\ &\quad +\beta \sum_{i',j'} Q(i',j',2;i,j) \left[\int_{z\geq \overline{z}(i',j')} S(i',j',z)\nu_{i'}(dz)\right] \\ &\quad +\beta \sum_{i',j',n'} Q(i',j',n';i,j) \left[b_{j'} + V_f + V(i',j')\right]. \end{aligned}$$

The first term on the right hand side is the expected present value of the match for unchanged z. That is, no new draw for the idiosyncratic productivity has arrived. However, states i and j may have changed, possibly leading to a negative surplus, and consequently a separation, so that only the outside options would be earned. Hence the max-operator, and the indicator $n = 1$. The second term denotes the expected present value of the match if idiosyncratic productivity in fact has changed. In that case, we have that $n = 2$, and the expectation over the draws of z is taken, conditional on the match not separating endogenously. This is the case when $z \geq \overline{z}(i,j) = \min\{z \mid S(i,j,z) > 0\}$. Finally, the third term reflects the values of the outside options. This is part of the continuation value for any $n = 1,2,3$. That is, when $n = 1$ or 2, the match at least earns $b_{j'} + V_f + V(i',j')$, but also in case of a separation, $n = 3$, when $S(i',j',z) < 0$.

The present value of unemployment (excluding the current flow benefit) to the

worker is

$$V(i,j) = \beta \sum_{i',j'} P(i',j';i,j) \left[\lambda^w \left(\pi \int_{z \geq \overline{z}(i',j')} S(i',j',z) \nu_{i'}(dz) \right) + b_{j'} + V(i',j') \right]. \tag{1}$$

With probability λ^w, the worker is matched to a new job, and, conditional on i', j' and $z \geq \overline{z}(i',j')$, earns a share π of the surplus in addition to her outside option. If not matched, with probability $(1-\lambda^w)$, the worker earns only the outside option $b_{j'} + V(i',j')$. Alternative

$$V(i,j) = \beta \sum_{i',j'} P(i',j';i,j) \left[\lambda^w(i',j') \left(\pi \int_{z \geq \overline{z}(i',j')} S(i',j',z) \nu_{i'}(dz) \right) + b_{j'} + V(i',j') \right]. \tag{2}$$

3.3 Wages

We assume Nash bargaining between worker and firm, with the wage payment maximizing the joint surplus. Absent risk aversion, this results in a linear sharing rule, with the surplus accruing to the worker being a fraction π of the joint surplus, as assumed above. Therefore the wage $w(i,j,z)$ is defined by

$$w(i,j,z) + G^W(i,j,z) - (b_j + V(i,j)) = \pi S(i,j,z)$$

with

$$G^W(i,j,z) = \pi \left[G(i,j,z) - \beta V_f \right] + (1-\pi)\beta \sum_{i',j',n'} Q(i',j',n';i,j) \left[b_{j'} + V(i',j') \right],$$

which is the (gross) continuation value for a worker on a job characterized by i, j, and z. This value is a weighted average of the worker's share of the job's net value, and the worker's outside option. Using the wage equation and the definition of the surplus, the wage can be brought into a familiar form:

$$\begin{aligned} w(i,j,z) &= \pi \left[(1-\tau)z - (1-\beta)V_f \right] + (1-\pi)\left(b_j + (1-\beta)V(i,j) \right) \\ &\quad -(1-\pi)\beta \left(\sum_{i',j',n'} Q(i',j',n';i,j) \left[b_{j'} + V(i',j') \right] - V(i,j) \right) \end{aligned}$$

The wage is a weighted average of the flow product of the firm and the discounted outside option of the firm, on the one hand, and the outside opton of the worker, on the other. The last term is the option value of employment, which has a negative effect on the current wage because of the associated chance of higher wages in the future should the worker fall back into the unemployment pool.

3.4 Free entry

In equilibrium, the fallback option of firms V_f must equal the cost of creating jobs. New jobs enter the market whenever the benefit of posting a vacancy exceeds its cost, V_f. Thus it must be that[12]

$$V_f = \sum_{(i,j)\in U} \lambda^f(i,j)\,(1-\pi)\,\beta \int_{\overline{z}_{i,j}}^{\infty} S(i,j,z)\nu_i(dz) + \beta V_f,$$

where the set U denotes the possible states that unemployed workers can be in. The entry cost must equal the firm's share in the surplus that a succesful match produces. Changes in parameters will change the right hand side and thus lead to either a fall or rise in vacancies, and subsequently falling or rising employment, until equality is restored in equilibrium.

3.5 Government

Expenditure on unemployment benefits depend on the masses of workers in the different unemployment states, while the tax revenue depends on the productivity levels z for the various types of productive employment relationships. Thus, to calculate the tax revenue, we need to make use of the distributions of workers across types, as well as the distribution of z within types:

$$\chi + \sum_j \sum_i b(j)u(i,j) = \sum_j \sum_i e(i,j) \int_{\underline{z}(i,j)}^{\overline{z}(i,j)} \tau_i(z) z dv_i(z) \tag{3}$$

where $u(i,j)$ and $e(i,j)$ are the shares of unemployed and employed workers, respectively, in the different skill and benefit classes. As in Siassi (2006), we introduce

[12] See also Den Haan, Haefke, and Ramey (2005), p.1368. Equivalently, we could subtract βV_f from the right-hand side, and define a vacancy creation cost $v_f = (1-\beta)V_f$.

an expenditure component χ, that represents expenses other than unemployment benefits. Not doing so would lead to unrealistically low tax rates. In part of the simulations, we will keep the tax rate constant, and see how welfare reform affects the budget. Then we also consider tax changes that keep the budget balanced after reform.[13]

Unemployment benefits are proportional to the *average* wages earned by workers in the two different skill groups. That is, we take average earnings capacity as the determinant of unemployment entitlements rather than taking account a worker's wage earned in the last period. Doing so would vastly expand the state space and thus the computational burden, without much additional insight. To be precise, benefits for workers previously with high skills on their last job are given by

$$b_1 = \phi \sum_{i=1,2} \sum_j \frac{e(i,j)}{\sum_j e(i,j)} \int_{\underline{z}(i,j)}^{\overline{z}(i,j)} w(i,j,z) \frac{v_i(dz)}{1 - v_i(\overline{z}(i,j))}$$

and

$$b_2 = \phi \sum_j \frac{e(3,j)}{\sum_j e(3,j)} \int_{\underline{z}(3,j)}^{\overline{z}(3,j)} w(3,j,z) \frac{v_3(dz)}{1 - v_3(\overline{z}(3))}.$$

For the first benefit level, one needs to take account of the different masses of workers who are in the two high-skill classes $i = 1, 2$ and the various possible benefit entitlements (or flow outside options) $j = 1, 2, 3$ which affect wages. For the second benefit level, only the class $i = 3$ for low skilled workers is relevant. Calculating the unemployment benefits thus requires knowledge of the distribution of workers across skills and benefit entitlements (while on the job), and of the conditional distribution of wages across idiosyncratic productivities z. The welfare benefit earned after income-dependent benefits have expired is calculated as a constant fraction $0 < \phi_a < 1$ of low skill benefits, i.e.,

$$b(3) = \phi_a b(2).$$

[13] Implicitly, we assume that the government uses the balance surplus to finance some public good that neither affects utility nor productivity in a manner relevant for the questions at hand.

This simple formulation makes sure that across simulations welfare entitlements are never larger than unemployment benefits. In fact, even though the actual German welfare benefits are specified in money terms, they are mandated to growth with the general wage level.[14]

3.6 Calibration

In large parts, we follow the calibration choices made by Ljungqvist and Sargent (2004, 2007). The model period is set to be quarters of a year, with a corresponding discount factor $\beta = 0.99$. There are three skill types and three benefit levels. Each skill type has productivities that are uniformly distributed. Low skilled workers' productivities are in the range $[0.5, 1.5] = [\underline{z}(3), \overline{z}(3)]$ with distribution v_3 and mean one. Productivities of highly skilled workers are distributed over the range $[1.5, 2.5] = [\underline{z}(i), \overline{z}(i)]$, $i = 1, 2$, with mean 2. Ljungqvist and Sargent (2004) base this assumption on observations on wage-experience profiles. We distinguish robust high skills and fragile high skills, which differ by the likelihood of skill loss. Denote their distributions by v_1 and v_2, respectively. Employed workers do not face a risk of skill loss, while unemployed workers do. Thus their high skills are not robust, but fragile. However, if they find a new job while still with fragile high skills, they quickly return to robust high skills.

In the initial calibration, unemployment benefits depend on previous income with net replacement rate $\phi = 0.6$, which was applied in Germany before the reforms.[15] Welfare benefits are assumed to be $\phi_a = 0.8$, or 80 percent, of the benefits that are received by workers who were low skilled upon job loss. Furthermore, we assume a small, but fixed across simulation, outside option of workers, which could be interpreted as a value of home production. The value is $\bar{h} = 0.04$, and was the only parameter used to target the level of the unemployment rate

[14] In a robustness section, we specify welfare alternatively as $b(3) = \phi_a \overline{w}$, where $\overline{w}$ is the average wage level.

[15] See also Nie (2010).

before the reforms.[16] Together with the other parameters, these values generate an unemployment rate of 10.3%, which is close to the actual rate in Germany at the beginning of 2005. Note that we take here the ILO standardized measures of unemployment rates, which are lower than the nationally reported rates. The average tax rate is set to $\tau = 30\%$. Workers and firms are taxed equally. Since bargaining is efficient, it is irrelevant who pays the tax, so we assume that they bargain over the after tax revenue $(1 - \tau)z$.

Transitions take place with the following probabilities. New productivies are drawn from v_i, $i = 1, 2, 3$ either when a match between worker and firm is newly formed, or during employment with arrival frequency $\gamma_s = 0.075$. Thus on average, productivity changes only every three years and three months. This induces persistence in idiosyncratic productivity levels. During employment, low skills become fragile high skills with probability $\psi_f = 0.025$ each quarter. Fragile high skills become robust high skill with probability 1. The distinction becomes relevant only during unemployment. In that state, robust high skills become fragile with probability $\gamma_r = 1$, and fragile high skills become low skills with $\gamma_d = 0.25$. Thus, workers with fragile high skills would still be more productive if they found a new job, but they face a higher risk of skill depreciation during unemployment. Were they to find a job soon enough, their skills would immediately turn robustly high again.

Benefit entitlements change during employment depending on the skill level of the worker. The probabilities are motivated by the time it takes by law to be eligible for a higher benefit level.[17] For a high skill (and thus high wage) worker, low benefits become high with probability $\psi_{lh} = 0.125$, while high benefit entitlements fall with probability $\psi_{hl} = 0.25$ if a worker is low-skilled. The latter may occur

[16] The welfare benefit rate is difficult to pin down, but we wanted to pick a number below, but relatively close to the lowest unemployment benefits. A fraction of unemployed workers did in fact receive welfare benefits that were even higher. Note that the Hartz IV welfare benefit should be a fixed value such as 345 Euros plus allowance for housing, heating, etc. Here we choose to have it endogenously in some relation to the general wage level.

[17] Again, see Ebbinghaus and Eichhorst (2009).

when a formerly unemployed worker has high benefit entitlement even though her skills had depreciated. For employed workers previously on welfare benefits, the transition rates to high and low benefit entitlements are $\psi_{ah} = 0.125$ and $\psi_{al} = 0.125$, respectivly. Thus it takes two years on average to gain full entitlements when having found employment after receiving welfare benefits. During unemployment, workers receive benefits depending on their previous skill level (and thus average wage), until a transition into welfare, which occurs with probability $\gamma_a = 0.05$. Thus it takes about 5 years on average until workers drop out of the unemployment insurance system. An even lower value for γ_a may be realistic, since in the old system, the unemployment assistance paid after unemployment insurance expired, lasted even longer.

Transitions between employment and unemployment are governed by a job separation rate and job and worker finding rates. The separation rate is partly exogenous and takes place with probability $\rho_x = 0.02$ per quarter. Furthermore, workers separate when their idiosyncratic productivity is under a critical value below which it is not profitable for firm and worker to continue the match (or a new match not being profitable to start producing).[18]

The matching function has functional form $m(v, u) = mv^{1-\mu}u^{\mu}$. Defining labor market tightness $\theta = v/u$, we can write $\lambda^w = m\theta^{1-\mu}$, and $\lambda^f = m\theta^{-\mu}$. The scale parameter is set to $m = 0.3$ following Ljungqvist and Sargent (2007). The match elasticity is $\mu = 0.5$. Strictly speaking, these are rates at which firms and workers contact each other, but not match formation rates. The actual rates of match formation depend also on how many contacts are actually profitable after the productivity draw for z. For low-skilled, high-benefit unemployed workers, the likelihood of entering production is much lower for a given draw of z. For the solved model, the assumed finding rates imply a particular present value of a posted vacancies.

[18] We do not consider separations due to job to job transitions, as they would only take place if they preserve a worker's human capital. Skill loss is only a problem after job loss.

Table 1: Calibrated parameters

Parameter	pre-reform (baseline)	post-reform if change
Discount factor, β	0.99	
Distr. of low skill productivities, uniform	$v_3 \sim [0.5, 1.5]$	
Distr. of high skill productivities, uniform	$v_1, v_2 \sim [1.5, 2.5]$	
Match efficiency, m	0.3	
Match elasticity, μ	0.5	
Exogenous separation probability, ρ_x	0.02	
Probability of skill upgrade, ψ_f	0.025	
Probability of productivity change, γ_s	0.075	
Probability of skill downgrade, γ_d	0.25	
Entitlements changes during employment:		
high skill worker, from low benefit, ψ_{lh}	0.125	
low skill worker, from high benefit, ψ_{hl}	0.25	
high skill worker, from welfare, ψ_{ah}	0.125	
low skill worker, from welfare, ψ_{al}	0.125	
Transition in to welfare, γ_a	0.05	0.25
Policy parameters		
tax rate, τ	0.3	
replacement rate for benefits, ϕ	0.6	0.53
welfare, relative to low-skill benefit, ϕ_a	0.8	0.7

The model is solved numerically via value function iteration on a discretized state space. For the approximation, the distributions v_i for z are divided into grid points. The value function iteration uses the Bellman equations defined above to find the optimal values of unemployment, employment, as well as job values, for each state that a worker can be in, given the optimal choice of cutoffs for z below which jobs are destroyed. The resulting value of a vacancy are generally not identical to the job creation cost for new jobs assumed in the above procedure. A second loop finds the fixed point for the job creation cost for the benchmark – initial – calibration. For the policy experiments, we take that cost as given but endogenize the worker and firm finding rates to ensure that the calculated creation cost equal the actual value of vacancies in equilibrium.

4 Simulation of the German labor market reforms

As the labor market reforms affect both the structure and cyclical adjustment of the labor market, we consider the two in turn. We begin the simulations by characterizing the situation before the labor market reforms in 2005, aiming to match the level of unemployment, given the institutional framework governing the German labor market. Then we conduct the simulation of reducing the duration and the level of unemployment and welfare benefits, reporting the differences in terms of the composition of the labor force, the skill level distribution of the workforce, and the duration of unemployment for the different worker types. Furthermore, we consider the effects of reforms on wages and aggregate output.

In the second part of this section, we analyse how the labor market responds to changes in aggregate parameters. Such changes we treat as representing both structural shifts as well as cyclical shocks. There are three main experiments: an increase in the tax rate (as a proxy for falling markups and/or productivity), an reduction in the discount factor (representing a higher interest rate, reflecting

tightening financial market conditions), and an increase in the efficiency in the matching process (which may reflect increased mismatch in the labor market). All these factors may have been at work during the crisis of 2008/2009. In particular the latter is a candidate for having driven up the U.S. unemployment rate and duration.

The analysis of labor market reforms proceeds in two steps. We first describe the status quo ex ante, before the reforms were introduced in January 2005. We also distinguish two tax policies. In the first, the government is assumed to keep tax rates unchanged after the reforms, in spite of the rising tax revenue and falling expenditure. The second tax policy changes tax rates such that the relevant expenditure again equals revenue.

4.1 Steady state before the reforms

Recall that the benchmark calibration implies an equilibrium unemployment rate of 10.3%, which is roughly the actual value in Germany in 2005. The replacement rate is 60 percent of net wages and the duration of unemployment insurance benefits is set to be five years on average. In that steady state, average wages earned by experienced high-skilled workers are $\bar{w}_h = 0.74$, and for workers with low skills $\bar{w}_l = 0.32$. Skilled workers earn on average higher than their share of the after tax product $\pi(1-\tau)\bar{z}_h = 0.7$, mainly due to their benefit entitlement which strengthens their outside option. Unskilled workers earn less than $\pi(1-\tau)\bar{z}_l = 0.35$, since their employment relationship also entails the option value of a skill upgrade and commensurate increased benefit entitlement in the future.

The unemployment benefits are $b_h = 0.48$, $b_l = 0.24$, for previously high and low skilled workers, respectively, and $b_{\text{welfare}} = 0.20$ for the long-term unemployed on the lowest welfare entitlement. These benefit values are reported under inclusion of the fixed outside flow value of home production $\bar{h} = 0.04$. One can see that a large part of the wage payment is due to favorable outside options. With the tax rate at $\tau = 0.3$, total tax revenue is 9.4, while total expenses for unemployment

benefits and welfare are about 0.04. This leaves a surplus of $\chi = 9.36$, as defined in equation (3).

The job flows in steady state are as follows. While all jobs are destroyed at the exogenous separation threshold $\rho_x = 0.02$, the endogenous separation rates show some heterogeneity. First of all, jobs with high skilled workers never break up endogenously, so their job destruction rate is 2% per quarter. In contrast, jobs with unskilled workers receive productivity draws that are below the critical thresholds, resulting in endogenous job separation rates for these types of workers of $\rho_h = 0.0417$, $\rho_l = 0.0243$, and $\rho_{\text{welfare}} = 0.0201$, where the subscripts indicate the different benefit entitlements of the unskilled workers. These values correspond to critical thresholds for z of $\underline{z}_{3,1} = 1.06$, $\underline{z}_{3,2} = 0.82$, and $\underline{z}_{3,3} = 0.77$. By virtue of the uniformity assumption, they translate into separation rates by subtracting the lower bound for the low skilled distribution $\underline{z}_3 = 0.5$, and multiplying with the arrival rate of new productivity draws, $\gamma_s = 0.075$. Given that mean productivity of low-skilled worker is 1, the threshold for low skilled workers with high benefit entitlement $\underline{z}_{3,1}$ appears high. It applies only to a small fraction of employed workers, but as we see presently, to a sizable fraction of the unemployed, keeping them from finding employment.

Labor market tightness before the reforms is $\theta = 1.32$, which imply job finding probabilities of $\lambda_w = 0.35$ for workers and $\lambda_f = 0.26$ for firms, close to the values assumed by Ljungqvist and Sargent (2007). However these are contact and not job filling probabilities for low skilled workers, which are determined in combination with job acceptance probabilities. These are implied by the thresholds. For example, a low skilled worker with high benefit entitlement will reject 56% of the job offered after a contact. High-skilled workers accept all jobs they contact. The resulting average outflow rate for unemployed workers is then 0.246, which implies a realistic average unemployment duration of 4.07 quarters, which is about a year.[19]

Workers flow between employment and unemployment, and between the differ-

[19]The outflow, or job finding, rate is determined from as the average job finding rate across

Table 2: Effects of labor market reforms

Variable	pre-reform	post-reform
	(baseline)	
Unemployment	10.3 %	7.77%
Average wages, skilled workers	0.74	0.73
Average wages, unskilled workers	0.32	0.32
Unemployment benefits;		
previously skilled, b_h	0.48	0.44
previously unskilled, b_l	0.24	0.21
welfare benefit, b_{welfare}	0.20	0.16
Tax revenue	9.40	9.81
Expenditure for welfare system	0.04	0.02
Budget surplus	9.36	9.79
Labor market flows		
labor market tightness, θ	1.32	1.95
contact rate, workers, λ_w	0.35	0.42
contact rate, firms, λ_f	0.26	0.22
job rejection probabilities for:		
unskilled, high benefits, $\underline{z}_{3,1} - 0.5$	56%	42%
unskilled, low benefits, $\underline{z}_{3,2} - 0.5$	32%	34%
unskilled, welfare, $\underline{z}_{3,3} - 0.5$	27%	30%
average outflow rate from unemployment	0.243	0.323
job separation rates ($\rho_x + \rho_i$, $i = h, l$,w)		
unkilled, high potential benefits, ρ_h	6.17%	5.17%
unskilled, low potential benefits, ρ_l	4.43%	4.57%
unskilled, potentially welfare, $\rho_{\text{w.}}$	4.01%	4.27%

ent skill and entitlement types, according to both the exogenously given and the endogenously determined probabilities. The different probabilities determine the stocks of workers that reside in the various categories. Table 3 gives the equilibrium break-up of the skill-benefit composition of the workforce, where the upper half concerns the situation before the reforms. Since high-skills become fragile upon job loss, no unemployed worker has robust high skills. The largest fraction (21.9%) of high-skilled unemployed workers naturally has high benefit entitlements, because they separated from high-skilled jobs. But the majority of the unemployed is made up of low-skilled workers, of which 60.8 percent reveive unemployment insurance benefits, and only 14 percent welfare payments. A quarter of the low skilled unemployed have high benefits, based on their preivous earnings when they had still high human capital.

Of those in employment, almost two-thirds (65.5%) are workers who have accumulated skill on the job, and have the correpondingly high benefit entitlement were they to become unemployed. Recall that once a worker has reached a high skill level, only the exogenous separation rate applies, which is relatively low. Most of the low-skilled workers also have the correpondingly low benefit entitlement. Observe that even though a quarter of the unemployed is low-skilled with high benefits, only a small fraction of such workers is in employment. This is due to the much higher threshold $\underline{z}_{3,1} = 1.06$, which lets these workers accept less than half the jobs they have contacted after job search.

4.2 Labor market reforms

In this section, we first simulate the German labor market reforms by solving the model for lower unemployment benefits, lower welfare payments, and most notably a much lower duration of the entitlements to earnings-dependent benefits. We

unemployed workers of skill j and benefit j, as in Table 3, that is,

$$\lambda_w \sum_i \sum_j \left[1 - (\underline{z}_{i,j} - 0.5)\right] u(i,j).$$

Table 3: Distribution of workers across types, before and after Hartz IV reforms

Before Reforms	unemployment				employment			
entitlements	b_h	b_l	b_{welfare}	sum	b_h	b_l	b_{welfare}	sum
skills								
high-skill, robust	0	0	0	0	65.4	3.9	0.8	70.1
high-skill, fragile	21.9	1.5	1.5	24.9	0.7	0.7	0.1	1.4
low-skill	25.9	34.9	14.3	75.1	1.7	23.9	2.9	28.4
sum	47.8	36.4	15.8	100	67.7	28.4	3.9	100
After Reforms								
skills								
high-skill, robust	0	0	0	0	66.2	3.1	2.8	72.2
high-skill, fragile	23.9	1.3	6.1	31.3	0.5	0.5	0.5	1.5
low-skill	8.6	23.6	36.6	68.8	0.7	19.2	6.4	26.4
sum	32.5	24.9	42.7	100	67.5	22.9	9.7	100

report the changed job acceptance thresholds, labor market tightness, and benefit payouts, i.e., replacement rates times new equilibrium wages. Also, overall output gains are split up into the effect from higher employment and the effect of a better skill composition of the workforce. Then we discuss the relative contributions of benefit level and benefit duration. Finally, we show the dynamic evolution of the labor market to its new steady state.

4.2.1 Stocks and flows

First consider the post-reform fractions of unemployed and employed workers across the different skill categories. Return to Table 3 where the lower half shows the new values after the reforms. The composition of the unemployed workforce changes dramatically. Due to the shortened benefit duration, a much smaller fraction of low-skilled unemployed has high benefits, and also the fraction of workers with low benefit has dropped. Therefore, also the absolut numbers have fallen. In contrast, a much larger fraction of those without jobs is now on welfare, which is

in absolut terms almost twice the number before the reforms.

Employment rises, and with it the fraction of high-skilled workers with high benefit entitlements. This is the main reason for an increase in aggregate output. It reflects that workers who lose jobs find new employment faster, without the detrimental skill loss that happens over time. The economy generates a more stock of, on average, more experienced workers. Also the outflow of workers on welfare must be higher, because the fraction of employed workers formerly on welfare benefits is larger. This is driven by the higher match probability with firms and the higher number of job searchers on welfare. But the effects should not be interpreted as indicating that there is now more long-term unemployment of the poor. It is simply that workers transit into welfare at a much faster rate.

The reforms reduced the replacement rate for earnings dependent benefits from 60% to 53% and their high duration down to *one* year only, with some exceptions, for example for older workers. We proxy this by a increase of the expiration probability from $\gamma_a = 0.05$ to 0.25. Furthermore, we reduce the replacement rate of welfare payments from 80% of low wage unemployment income to 70%, representing the strikter eligibility and means-testing of the new ALGII-welfare benefit, b_{welfare}. These measures lead to a reduction of the unemployment rate from 10.3 percent to 7.77 percent. This is a fall of 2.5 percentage points and amounts to a significant reduction, bringing the unemployment rate much closer to the rate observed in late 2010, of about 7 percent. Note that this reduction does not yet include a possible reduction in tax rates motivated by falling expenses for income support.

The flows between employment and unemployment change accordingly, and lead to interesting changes in the composition of the labor force. The job acceptance thresholds for new jobs change to $\underline{z}_{3,1} = 0.92$, $\underline{z}_{3,2} = 0.84$, and $\underline{z}_{3,3} = 0.80$. Thus they are lower for low-skilled workers on high benefits, but slightly higher for such workers with low beneftis or welfare. This is due to the increase in labor market tightness to $\theta = 1.95$. It raises outside options and thus pushes up wages in

all jobs, and therefore more than offsets the stimulating effect of lower benefits on the job acceptance rates. This is mirrored in the separation probabilities. Interestingly, this does not adversely affect the overall job creation rate, because at the same time, the job finding probability of the unemployed rises to $\lambda_w = 0.42$, while that for job falls to $\lambda_f = 0.22$. This is due to the overall higher number of vacancies relative to unemployed workers, θ. The implied average duration of unemployment for all workers falls to three quarters, rougly the inverse of the aggregate quarterly job finding rate of 0.323.

Unemployment benefits (wages times replacement rate) fall to $b_h = 0.44$, $b_l = 0.21$, for previously high and low skilled workers, respectively, and $b_{\text{welfare}} = 0.16$ for the long-term unemployed on the lowest welfare entitlement. At the same time, average wages for high-skilled workers fall slightly, to $\bar{w}_h = 0.73$, and those for low-skilled workers are barely changed at $\bar{w}_l = 0.32$. One may have expected a pronounced drop in wages after a cut in replacement rates and durations. Interestingly, higher job acceptance probabilities by unemployed workers increase the job-filling probabilities of firms, which in turn induces them to post more vacancies, as the rise in θ indicates. Through bargaining, the improved outside option of workers raises their wages to almost offset the drop in benefit entitlements.

4.2.2 Government budget

Reforms change government expenditure and income. There is a direct effect due to the saved welfare and benefit payouts per unemployed worker. There is an additional, indirect, effect due to the reduction in unemployment which further reduces total benefit payments. In the simulations above, we kept the tax rate fixed at 30 percent. In that case, the improved labor market conditions raise tax revenue to 9.81, by 4.26 percent, and expenses for the welfare state almost halve. Thus the budget surplus over welfare expenses, χ, rises by 4.59%. If the government uses the increased revenues to reduce tax rates, additional effects on the incentives for providing work and jobs may arise. We now simulate the reduction of the tax

rate by 4.8 percent, to 28.57 percent, which brings the budget surplus close to its previous level.

First of all, the tax cut stimulates job creation, bringing the unemployment rate further down, to $u = 7.58$ percent. This is only a small additional dividend, but reveals the full effect of labor market reforms, if the government does not use the saved revenue for other purposes. Labor market tightness rises to $\theta = 2.05$, reflecting the lower unemployment rate and higher number of vacancies. Interestingly, since the further improved labor market conditions strengthen workers' bargaining position, wages rise and therefore also unemployment benefit entitlements increase. Thus in spite of the fall in the number of receipients, the sum of benefit payouts is actually slightly higher (by 2.5 percent) after taxes were lowered.

4.2.3 Transitional dynamics

The transitional dynamics of the economy after the welfare system has changed offer some further insights into the working of the labor market. Figure 3 shows the adjustment of the unemployment rate, in the aggregate, and of its components. First of all, the transition takes place relatively fast. The main impact of the reduction in benefit levels and benefit duration has taken place after about two years, even though the unemployment rate continues to fall further in subsequent periods. Interestingly, the strongest reduction is in the number of unskilled workers, which are those that had lost their skills already, and are thus most likely to be long-term unemployed. This is due mainly to the lower reservation productivities of workers when they contact a new job opening, so that less workers lose their skills in the first place.

The model reveals a much larger degree of inertia than the standard search and matching model. In simple versions of that model, one can proxy for cyclical changes by conducting steady-state comparisons, due to the fact that labor market tightness and unemployment instantaneously adjust.[20] In models with heterogene-

[20] See Pissarides (2010) and Shimer (2005).

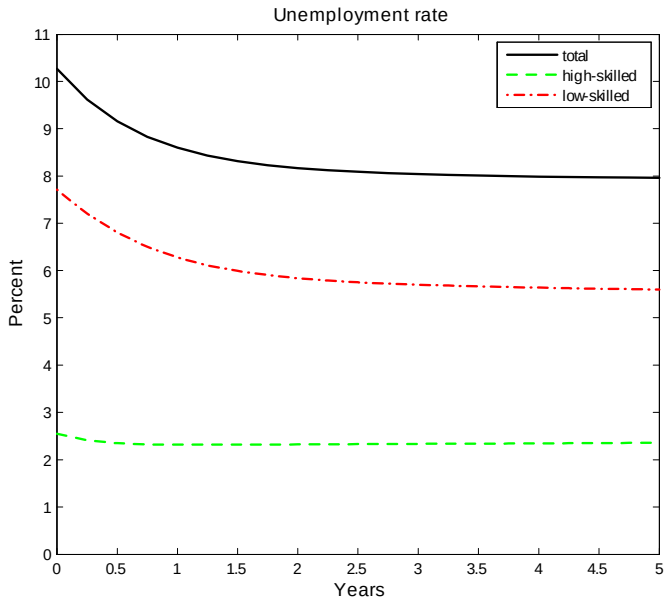

Figure 3: Adjustment of German unemployment after the Hartz IV reforms

ity this need not no longer be true.[21] For example, in our model, the accumulation of skills detaches workers somewhat from movements in labor market tightness, breaking the tight link between their wages and labor market conditions. This explains the protracted adjustment which stretches over a number of years, rather than concluding within a quarter.

The aggregate adjustments hide the heterogeneity in the flows of workers according to their skills and benefit entitlements. The probabilities of transiting between these states varies across worker types. Figures 4 and 5 show the corresponding transitions in the stocks of high- and low-skilled workers. Low skilled workers, who make up the majority of the unemployed, are shown in Figure 4. The stock of low-skilled workers who have high benefit entitlements drops. This is due to the reduction in the duration of the entitlement, which forces them to transit to welfare after a year on average. The same applies to workers who previously

[21] The same applies to models with on-the-job search. See Krause and Lubik (2010) for an illustration.

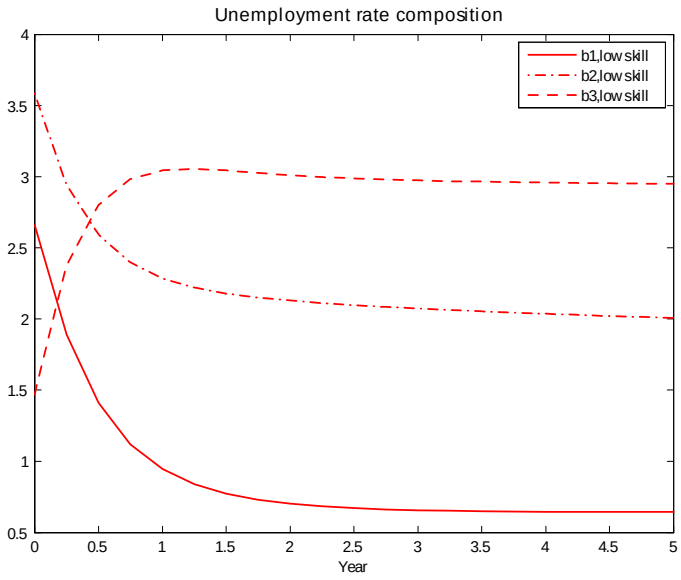

Figure 4: Evolution of low skilled unemployment, by benefit entitlement

earned lower wages. At the same time, the number of workers on welfare (Arbeitslosengeld II) rises. But overall, the total unemployment rate for low skilled workers drops, as was seen in Figure 3.

The evolution of high-skilled employment is shown in Figure 5. Here the effects are less pronounced. Again, the number of workers with high entitlement drops, due to the fact that they transit faster to the welfare benefit. Similarly, high-skilled workers on low benefits falls, but only slightly. Notably, the number of high-skilled workers on welfare benefits rises somewhat. This is due to the increased fraction of high-skilled workers who have entered welfare before finding a job, and workers of the same type who flow out of employment for exogenous reasons. Again, the fact that the number of workers on welfare is higher after the reforms is not necessarily a mistake in its design. The shorter duration of earnings-dependent unemployment benefits creates incentives for job search and acceptance that raises the overall employment rate and the quality of the workforce.

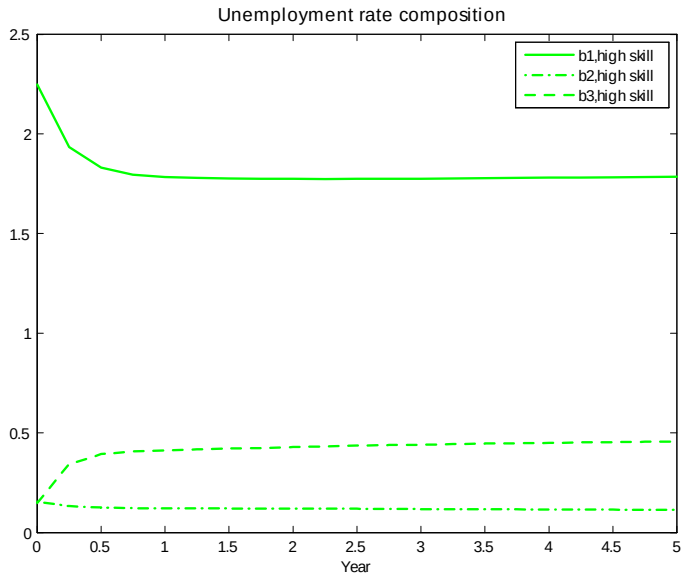

Figure 5: Evolution of high skilled unemployment, by benefit entitlement

4.3 Shocks

The structural changes discussed above are a policy induced change in the workings of the labor market, with strong effects on the duration of unemployment and the steady state flows between jobs. Other changes in aggregate parameters will have possibly strong effects on labor market outcomes. During the economic crisis of 2008 and 2009, the global economy has experienced a severe downturn in output, with generally detrimental consequences for the labor market. Here we consider three types of shocks, to productivity, to the discount factor, and to matching efficiency, which partly proxy for contractionary shocks during the crisis, or reflecting the consequences of such shocks for the labor market.

In all experiments, we assess the effects of permanent change of aggregate parameters in two ways. One focuses on their instantaneous impact, holding unemployment benefits constant. The second is the long-run effect of a change, including the endogenous change in benefit to whatever long-run change in wages induced by the shock. We regard the former as a useful approximation for the initial reaction

to shocks, for three reasons. First, most unemployed workers' benefits are based on their past, pre-shock earnings. Secondly, only a relatively small fraction of workers lose their job each period, so the inflow into unemployment pool is small, keeping its composition largely unchanged. And thirdly, even though continuously rebargained wages should immediately reflect the worsened outside options of employed workers, fixed benefits may to some extent proxy for the short-run implications of wages rigidities, in particular downward.[22]

4.3.1 Productivity shock

A shock to productivity may be a valid approximation to the European condititions during the crisis, since productivity has dramatically fallen there. In contrast, U.S. productivity has been increasing throughout the crisis. On the other hand, the skill composition of the workforce may have worsened, as more low skilled workers lost their jobs, and the remaining workers are high-skilled. In the model, shocks to average productivity affect workers and firms alike, since they continuously split the proceeds of a job. A negative shock reduces current and future output, and thus job creation, and therefore increases unemployment. Consider the second column in Table 4 where we compare the short- and long-run responses to a one-time, five-percent, downward shift in all idiosyncratic productivities, and hence output. This is a magnitude experienced during the crisis, at least in Europe. The short-run effect of the productivity shock leads to an increase in the unemployment rate by about 1 percentage point, for given unemployment benefits. The budget situation worsens, as revenue falls from 9.81. The drop in productivity reduces job creation incentives, so that labor market tightness falls to θ =1.58, from the initial 1.95, thus the contract rate falls. In the long-run, the effect of the shock is mitigated by the endogenous adjustment of unemployment benefits, which fall as wages fall. For the productivity shock, this implies a smaller increase in the unemployment rate, a tigher labor market and improved budget.

[22] Obviously, the short-run effects of shocks deserves further detailed scrutiny.

Table 4: Table Caption

Shock	Productivity		Discount factor		Match efficiency	
	$\Delta\bar{z}/\bar{z} = -5\%$		$\beta = 0.988$		$m = 0.27$	
Adjustment	short	long	short	long	short	long
Variable						
Unemployment	8.8 %	8.4%	12.3%	10.8%	8.6%	8.5%
Unemployment benefits;						
previously skilled, b_h	0.44	0.41	0.44	0.38	0.44	0.44
previously unskilled, b_l	0.21	0.19	0.21	0.16	0.21	0.21
welfare benefit, b_{welfare}	0.16	0.15	0.16	0.13	0.16	0.16
Tax revenue	9.59	9.70	9.01	9.26	9.62	9.63
Expenditure for welfare system	0.02	0.02	0.03	0.02	0.02	0.02
Budget surplus	9.57	9.68	8.98	9.24	9.60	9.61
Labor market flows						
labor market tightness, θ	1.58	1.69	0.85	1.02	1.72	1.75
contact rate, λ_w	0.38	0.39	0.33	0.30	0.36	0.36
contact rate, λ_f	0.24	0.23	0.28	0.30	0.21	0.20
job rejection probabilities for:						
unskilled, high benefits	45%	42%	46%	42%	40%	39%
unskilled, low benefits	35%	34%	36%	33%	30%	30%
unskilled, welfare	31%	31%	32%	31%	26%	26%

4.3.2 Discount factor shock

In our real model, a negative discount factor shock is contractionary since firms dicount the future more heavily, in our simulations from $\beta = 0.99$ to 0.988. This reduces the time horizon in which job creation costs must be recuperated, thus reducing job creation incentives. This may be seen as a reflection of aspects of the crisis, which led to higher real interest rates for both firms and households.[23] In Table 4, the discount factor shock shows the largest difference between the short-run and the long-run. In the short-run, the unemployment rate rises to 12.3% with a substantially worsening government budget, and rising welfare expenses. This is an increase of 4.5 percentage points. Labor market tightness drops strongly, to less than half the pre-shock level, and the job finding rate for workers drops correspondingly. The likelihood of rejecting a job, and with it also the job destruction rate, increases for all worker types.

The long-run effect of the discount factor shocks shows a much smaller increase in the unemployment rate, though still at a hefty 10.8 percent. This descrease is achieve through the fall in unemployment benefits, which drop along with the falling wage level. The budget somewhat improves, and the job finding rates recover. Also, job finding probabilities return closer to the pre-crisis levels.

4.3.3 Matching efficiency shock

The third potential shocks that potentially plays a role in the crisis and its aftermath is a change in the efficiency with which the labor market allocates workers to new jobs. A decline in match efficiency leads to less matches being generated for a given number of vacancies and unemployed workers, so that unemployment is bound to rise. In the U.S., this may explain the increase in unemployment, which persists at a high level even though many of the precipitating factors of the crisis have waned. Ultimately, the shock may reflect the decreased mobility of the

[23] Indeed, shocks to the discount factor are frequently employed to generate contractions in models to analyse the Great Depression. See Auerbach and Obstfeld (2005), and Eggertson (2008).

U.S. workforce, after falling housing values prohibit workers from taking up jobs at other locations.

We subject the labor market to a ten percent decline in the parameter m of the matching function. The matching efficiency shock, even though leading to a similar decline in employment as the technology shock does not show strong differences in the long-run and the short-run. The unemployment rate is about 0.8 percentage points higher than in the baseline. One could of course imagine a much larger shock to generate a stronger increase in unemployment, but we leave this for the future.

4.4 Labor market stabilization policies

There are two basic stabilization policies that we consider here, one affecting the demand side of the labor market, and one affecting the supply side. The former is a labor subsidy that the government pays to firms in order to prevent the destruction of otherwise, at least temporarily, unproductive jobs. It is in the spirit of the short-time work allowance applied by many European governments during the crisis. The latter policy is an increase in the duration of unemployment benefits, a policy U.S. governments regularily introduce during recessions. As mentioned, in the current recession the duration of benefits in the U.S. has been extended from the usual 6 month to almost two years.

4.4.1 A labor subsidy

The labor subsidy is meant to avoid the destruction of employment relationships that in normal times would not be separated. Especially during severe recessions this policy is believed that neither firms or workers are at no fault when the firm is in trouble, and that separations would be inefficient. In this section, we introduce a labor subsidy as a reduction in the tax rate for those jobs that are below the job destruction threshold. Specifically, we reduce the tax rate by a factor of one-half for those jobs where productivity is below the job destruction threshold. We pick

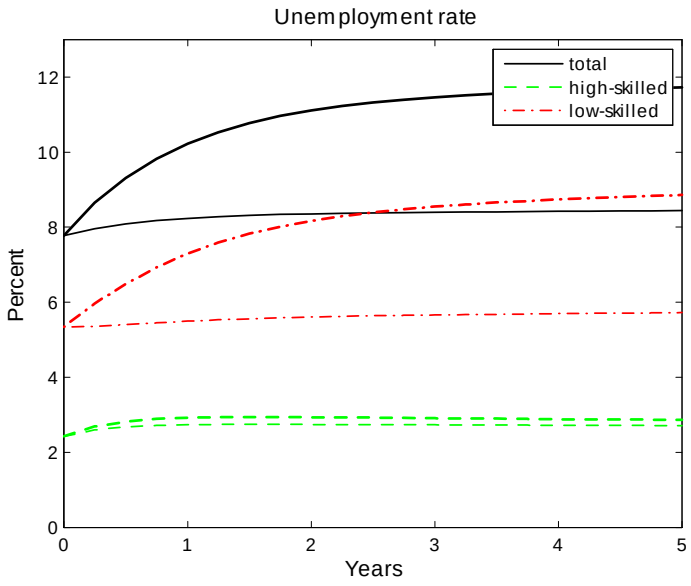

Figure 6: Effects of negative discount factor shock with and without a stabilizing labor subsidy.

the treshold for those jobs that have the highest mass, namely those with low-skilled workers with low benefit entitlement. Since only a small fraction of workers is low-skilled with high benefit entitlements, we ignore them. Otherwise, also job searchers who are choosy because of high entitlements would be subsidized.

Figure 6 shows the comparative evolution of unemployment for a discount factor shock, with (thin lines) and without the labor subsidy (thick lines). We consider the case where benefit entitlements are held fixed, to proxy for the fact that workers unemployed before the crisis will not experience a cut in their entitlement.[24] One can see that the labor subsidy can substantially reduce the impact of an adverse shock. Recall that without the subsidy, the unemployment rate would rise to 12.3 percent, while there is a drop in labor market tightness to $\theta = 0.85$. With the subsidy, it only increases to 8.5 percent. This is a very strong effect. Because of the subsidy, job creation is even slightly stimulated, so that θ rises to 1.18, but

[24] This differs from the reform experience, where unemployed workers suffered a cut in entitlements.

still far below the pre-crisis level of 1.95. Note that the main beneficiaries of the policies are the low skilled workers, whose unemployment rate would have increased by more than two percentage points. In constrast, the number of skilled workers in the unemployment pool is not affected much either way.[25]

Even though the subsidy is costly in terms of forgone revenue, it reduces government expenditure and increases revenue because of the substantial number of protected employment relationships, which do produce tax revenue. After the discount factor shock, revenue would have fallen to 9.01, and expenditure risen to 0.029, leaving a surplus for other spending items of 8.89. With the labor tax subsidy, these number are 9.52, 0.022, and 9.50, respectively. That is, the stimulating effect of the subsidy leaves the budget in better shape. However, note that this is no free lunch in the sense that the budget surplus would rise back to its pre crisis level. But it seems that this policy is less costly than expected.

4.4.2 Increasing benefit duration

In Europe, lengthening the duration of the unemployment benefit entitlement is not part of active labor market policies. In the model, this would of course amount to a reversal of the labor market reforms analysed earlier. For the U.S., we calibrate the model with the pre-crisis average duration of unemployment benefits entitlement and a replacement rate of 40 percent. Furthermore, we assume a lower income tax rate than in Germany, setting $\tau = 20\%$. It is difficult to determine the payments of the welfare system applying to the long-term unemployed in the U.S. Therefore we keep the welfare payment ratio ϕ_a at the previous value. These parameters together generates an unemployment rate of 5.6%, close to that observed in the years before the crisis, and a labor market tightness of $\theta = 3.3$, indicating a substantially more flexible labor market than in Europe.

[25] Note that the one-firm/one-worker model does not take the complementarities and correlation across jobs within establishments into account. Firm-specific factors would endanger all jobs in a firm, also those of the high-skilled workers. In this sense, there is no contribution of the subsidy in protecting valuable human capital. Analysing these issues would require development of a model with large firms, along the lines of Bachmann (2209).

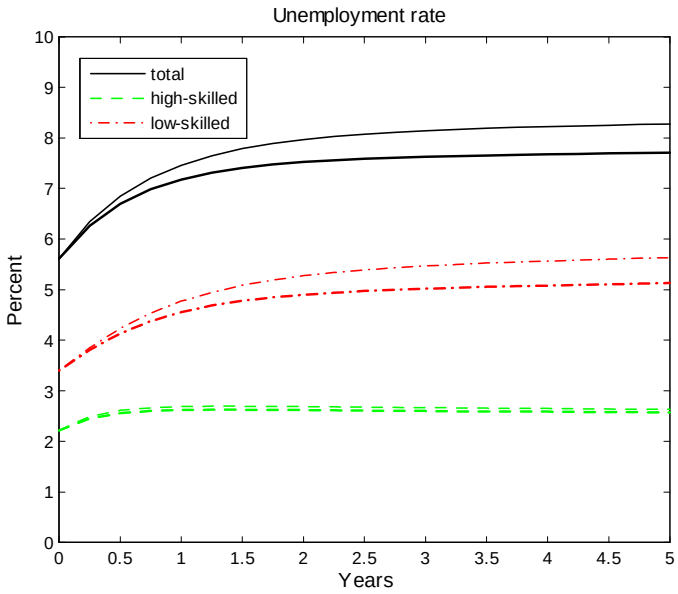

Figure 7: Change in U.S. unemployment after crisis shock, with and without higher entitlement duration.

The shock and the effect of the policy are shown in Figure 7. Again, the thick lines show the effects without policy, the thin lines with policy. Without increasing the duration of unemployment benefits, the discount factor shock raises the unemployment rate to almost 8 percent, a substantial increase of 2.4 percentage points. At the same time, labor market tightness θ drops to 1.75. Note that this is less than the response for the same shock in Europe, which raised the unemployment rate from 7.8 percent to 12.3 percent, by 4.5 percentage points. The question is how much the increased benefit duration has added to this. We take the maximum extension granted for 2010 of 99 weeks, implying $\gamma_a = 0.1313$. The effect of this policy on the unemployment rate is mild: it adds only half a percentage point, resulting in a rate of 8.56. Labor market tightness falls, to $\theta = 1.57$. From the perspective of the model, the high U.S. unemployment rate cannot be blamed on the increased duration of unemployment entitlements.

This finding of a mild effect of the higher benefit duration should not be taken as implying that a permanent change in entitlement duration has no severe conse-

quences, thus questioning the results obtained for the German labor market reforms simulated above. First of all, the increase in duration is comparatively low, from half a year to almost two years. The Reform experiment above started from an average duration of benefit entitlements of five years. Secondly, the replacement rate in the U.S. is lower, which somewhat reduces the detrimental effect of higher benefit duration.

5 Conclusions

It appears from our simulations that the performance of the German labor market since about 2005 may well be largely due to the reforms introduced at that time. The reforms have significantly reduced the duration of unemployment benefit entitlements and also lowered their levels. Workers now face much stronger, even if unpleasant, incentives to take up jobs, since their outside options of staying unemployed has become notably less attractive. In the model, we see a drop in unemployment duration and unemployment, while at the same time job finding probabilities for workers increase. An interesting observation is that the tightening of the labor market after the reforms strengthened workers bargaining position in spite of the drop in unemployment income. In fact, since wages are kept stable, unemployment benefits do not fall as much as they would have absent labor market adjustments.

Then we turn to the short-run adjustment of the economy to shocks that may be proxying for the consequences of the financial and economic crisis of 2008 and 2009, and analyse the labor subsidy that the German government has introduced in those years. The short-time labor subsidy pays workers and firms part of the wages to avoid potentially inefficient separations. We find that, if proxied by a tax cut for job whose productivity is below the critical job destruction thresholds, that the effects on the labor market can be strong. It may have made a significant contribution to keeping German unemployment from increasing during the crisis.

We also consider a U.S. calibration and simulate the strong increase in the duration of unemployment benefits, that was introduced since 2009. Here we find only weak effects on the unemployment rate, indicating that this policy is not at the root of the high U.S. unemployment and its duration.

In spite of some institutional detail and the consideration of shocks, our model gives still only a stylized representation of the labor market. It reduces important establishment heterogeneity to heterogeneity across jobs, without possibly complementaries between workers, which may lead to correlated risks also for high-skilled workers. Therefore there is also no lumpiness in the entry and exit of jobs. The destruction of entire plants and establishments is partly what short-time labor subsidies are designed to prevent. An analysis of this sort would require embedding our richer labor search dynamics into a full-fledged DSGE model such as Bachmann's (2009), which is high on our agenda.

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