# Labor Market Reform and the Cost of Business Cycles

**Tom Krebs**
**University of Mannheim***

**Martin Scheffel**
**University of Cologne**†

May 2014

## Abstract

This paper studies the effect of labor market reform on the welfare costs of business cycles. It develops a tractable search model with idiosyncratic labor market risk and risk-averse workers, and derives a convenient formula for the welfare cost of business cycles. The theoretical analysis shows that an increase in labor market flexibility reduces the welfare costs of business cycles. The paper also provides a quantitative analysis of the German labor market reforms of 2003-2005, the so-called Hartz reforms, which reduced unemployment benefits for the long-term unemployed and increased matching efficiency through improvements in job placement services. The quantitative analysis suggests that the German labor market reforms of 2003-2005 reduced the non-cyclical unemployment rate by 2.6 percentage points *and* reduced the welfare cost of business cycles by $20-40$ percent depending on the social welfare weights.

**Keywords**: Labor Market Reform, Cost of Business Cycles

**JEL Codes**: E21, E24, D52, J24

---

*Department of Economics, L7,3-5, 68131 Mannheim, Germany.

†Department of Economics, Albertus-Magnus-Platz, 50923 Cologne, Germany

# 1. Introduction

The Great Recession ended an era of macroeconomic stability and demonstrated that recessions can be very costly. These developments have renewed interest in business cycle research and sparked a debate about the type of government policy that is best suited to reduce the economic cost of adverse macroeconomic shocks. In this debate, academic scholars and policy makers have emphasized the importance of macroeconomic stabilization policy for reducing the cost of recessions, and policy making has been heavily geared towards this type of policy.[1] In this paper, we take a different approach and study to what extent labor market reform can reduce the costs of recessions. Specifically, we argue that labor market reforms enhancing labor market flexibility reduce the welfare costs of business cycles (recessions). In other words, structural reform of the labor market not only improves the long-run performance of the economy, but it can also reduce the economic costs of short-run fluctuations in aggregate economic activity. Specifically, well-designed labor market reform reduces the need for fiscal stimulus packages during recessions.

There is a simple intuition why labor market flexibility reduces the welfare costs of business cycles. Recessions are costly because both the number of unemployed workers and the individual cost of unemployment increase during a typical recession. A labor market reform that improves labor market flexibility increases the job finding rate, which dampens the hike of the unemployment rate during recessions. In other words, labor market flexibility makes the labor market more resilient to macroeconomic shocks. If the labor market reform also reduces the individual cost of unemployment, then this reform reduces the costs of recessions and therefore reduces the welfare costs of business cycles.

[1] The recent academic literature on the business cycle effects of macroeconomic stabilization policy is vast and we make no attempt to survey this literature. Akerlof and Yellen (2006) provide a summary of the standard arguments in support of counter-cyclical monetary policy, and Yellen (2013) provides an account of US monetary policy since the Great Recession and how it has been shaped by concerns for the labor market. The IMF World Economic Outlook October 2012 provides one of many examples how recent policy making has been strongly influenced by the view that counter-cyclical fiscal policy is an effective tool to reduce the cost of adverse macroeconomic shocks (see also Krugman, 2014). Our paper is also related to the recent work on cyclical labor market policy, which we discuss below.

In this paper, we study the link between labor market reform and the welfare cost of business cycles theoretically and quantitatively. To this end, we first develop a tractable macro model with job search, idiosyncratic labor market risk and incomplete insurance markets. We follow Lucas (1987, 2003) and compute the welfare costs of business cycles as the percentage of lifetime consumption that households are willing to give up in order to live in an economy without business cycles. In contrast to Lucas (1987, 2003), our approach allows for the possibility that business cycles have mean effects. Specifically, the elimination of business cycles may change the average job destruction rate. This generalization has two advantages. First, we can discuss the effect of labor market reform on the costs of recessions, which emerges as a special case of our general welfare approach and is a cost measure often used in applied work. Second, we can derive results about the effect of labor market reform on the gains from stabilization policy even in cases in which stabilization policy has asymmetric effects over the business cycle (i.e. the size of the fiscal multiplier depends on the state of the economy).

Motivated by the German labor market reform of 2003-2005, our analysis focuses on two labor market institutions: unemployment benefits determining search incentives and job placement services affecting matching efficiency. The theoretical analysis shows that an improvement in job placement services generally reduces the welfare cost of business cycles, but that a reduction in unemployment benefits has an ambiguous effect. The intuition for this result is simple. Clearly, both types of labor market reform increase the job finding rate and therefore reduce the response of the unemployment rate to macroeconomic shocks, which tends to reduce the cost of recessions. In the case of an increase in matching efficiency, individual losses of the unemployed are also reduced so that the overall effect on the welfare cost of recessions is unambiguously negative. In contrast, a cut in unemployment benefits may increase the individual loss associated with unemployment so that the overall effect on the welfare cost of recessions is ambiguous. We show, however, that a cut in unemployment benefits reduces the welfare cost of business cycles if pre-reform unemployment benefits are higher than the efficient benefit level.

Our quantitative analysis provides an assessment of the German labor market reform of 2003-2005, the so-called Hartz reforms, which turned "the sick man of Europe" into a "labor market miracle". Two essential ingredients of these reforms were i) a complete overhaul of the Public Employment Agency (Hartz III) dramatically improving job placement services and ii) a substantial reduction in the unemployment benefits for the long-term unemployed (Hartz IV) increasing search incentives. There is strong empirical evidence that, in line with the theoretical prediction, these two parts of the reform package led to a substantial increase in the non-cyclical component of the job finding rate of unemployed workers. This empirical evidence in conjunction with the scale of the German labor market reforms of 2003-2005 make them an ideal candidate for studying the interaction between labor market reform and the welfare cost of business cycles.[2]

For the quantitative analysis, we calibrate the model economy to German pre-reform data and then simulate the effects of the Hartz III reform and the Hartz IV reform using the available empirical evidence on the effect of these reforms on matching efficiency and search incentives. We find that the resulting increase in labor market flexibility led to a significant reduction in non-cyclical (steady state) unemployment. Furthermore, both reforms reduced the welfare costs of business cycles substantially, but Hartz III had a significantly larger effect. Overall, the two reforms taken together reduced non-cyclical unemployment by 2.6 percentage points *and* reduced the welfare cost of business cycles by $20-40$ percent depending on the weight the social planner assigns to different types of workers (employed vs unemployed). In particular, if policy makers are mainly concerned with the fate of unemployed workers, then the German labor market reforms reduced the welfare cost of business cycles by almost 40 percent.[3] Thus, these reforms were highly effective in reducing the wel-

[2]In the US, labor market policy has often been adjusted in response to business cycle conditions, the recent extension of unemployment benefit eligibility from 26 weeks to up to 99 weeks being a case in point. However, after WWII the US has not witnessed any permanent changes in labor market policy comparable to the Hartz reforms. Of course, most European countries introduced some type of labor market reform in the last 20 years, but they were either much more limited in scope than the Hartz reforms or the implementation was much more gradual.

[3]The macroeconomic literature usually assumes equal social welfare weights. In this paper, we use a

fare cost of business cycles and, in contrast to macroeconomic stabilization policy, they also improved the long-run performance of the German labor market substantially.

Our results imply that labor market reform changes the design of optimal stabilization policy once we take into account that macroeconomic stabilization policy also has economic costs (i.e. negative long-run output effects). For example, in response to the recent global financial and economic crisis, governments around the world have implemented large-scale fiscal stimulus programs, and these policy actions have sparked an extensive academic debate regarding the size of the fiscal multiplier. The voluminous literature has provided important insights by studying the effect of zero nominal interest rate bounds, cyclical conditions, financial frictions, and different types of fiscal measures (see Coenen et al., 2012, and IMF, 2012, for surveys). However, almost completely missing from the discussion is the structure of the labor market, and our results suggest that this ommission is not innocent. In particular, our analysis suggests that Germany, which implemented successful labor market reforms before the onset of the global economic crisis, needed much less aggregate demand stimulus during the crisis than European countries that did not reform their labor markets.[4]

In summary, this paper makes two contributions. First, it provides a theoretical analysis and shows that well-designed labor market reform reduces the adverse welfare consequences of recessions and therefore reduces the welfare costs of business cycles. Second, the paper provides a quantitative application of the general theory to one of the most important cases of labor market reform in recent history, namely the German labor market reform of 2003-2005. Our quantitative results suggest that this labor market reform led to a substantial reduction in the welfare costs of business cycles in Germany.

We conclude this introduction with two comments regarding methodology. First, we follow Lucas (1987, 2003) and discuss the welfare effects of macroeconomic stabilization

more general approach in order to capture the idea that policy discussions about the costs of recessions and stabilization policy often focus on the unemployed.

[4]Note that this argument is different from the argument that the appropriate policy response for each individual country depends on the size and persistence of the aggregate demand shock hitting the economy.

policy without explicitly modeling stabilization policy. Specifically, we take the job destruction process as exogenously given and then assume that stabilization policy eliminates the volatility of this exogenous process. This approach has two advantages. First, we do not have to commit to a particular model of stabilization policy and can therefore derive more general results. In particular, we show that the German labor market reforms have reduced the gains from macroeconomic stabilization policy by up to 40 percent independently of the type of stabilization policy under consideration. Second, our approach allows us to focus on one basic channel for which independent empirical evidence exists. More precisely, in this paper we emphasize that labor market reforms that increase the non-cyclical component of the job finding rate have the potential to reduce the welfare cost of business cycles, and in Section 2 and the Appendix we argue that there is ample evidence that the German labor markets reforms of 2003-2005 increased the non-cyclical job finding rate substantially.[5] Clearly, incorporating into the analysis explicit models of stabilization policy and models with endogenous job destruction rates are important topics for future research.

Our second methodological comment is concerned with the economic mechanism that generates non-negligible welfare cost of business cycles. Consistent with the evidence, we assume that unemployment leads to skill loss, and that skill loss increases with unemployment duration. For the calibrated model economy, skill depreciation during unemployment is sufficient to make recessions very costly, but the welfare costs of business cycles are only substantial if the elimination of business cycles eliminates the volatility of the job separation rate *and* reduces the mean of the job separation rate. Mean-effects on the job separation rate are not implausible. For example, they can occur if macroeconomic stabilization policy affects the labor market asymmetrically in the sense of being more effective in recessions than in booms – see Section 4.1 for a detailed discussion. Further, our theoretical and quantitative results are independent of the type of stabilization policy under consideration

[5]In standard search and matching models along the lines of Mortenson and Pissarides (1994) and Den Haan, Ramey, and Watson (2000), the labor market reforms considered here would increase the steady state job finding rate *and* reduce the volatility of the job destruction rate (see Costain and Reiter, 2008, and Kuhn and Jung, 2012) thereby proving an additional channel through which labor market reform reduces the cost of business cycles.

(i.e. the degree of asymmetry of stabilization policy). In particular, we show that the German labor market reform of 2003-2005 reduced the welfare cost of business cycles by roughly the same percentage amount regardless of the type of stabilization policy under consideration (fully symmetric or fully asymmetric) – 20 percent if equal social welfare weights are chosen and 40 percent if the social planner only cares about unemployed workers.

**Literature** Our paper is related to several strands of the literature. First, it is closely related to the large literature on the welfare cost of business cycles following the seminal contribution of Lucas (1987). This literature has extensively studied to what extent the introduction of uninsurable idiosyncratic risk increases the welfare cost of business cycles. For example, Atkeson and Phelan (1994), Imrohoroglu (1989), and Krusell and Smith (1999) analyze cyclical fluctuations in unemployment rates and unemployment duration and Gomes, Greenwood, Rebelo (2001) introduce endogenous search effort. Krebs (2003) and Storesletten, Telmer, and Yaron (2001) study cyclical variations in labor income risk more generally and Beaudry and Pages (2001) and Krebs (2007) focus on the long-term earnings losses associated with job displacement. The literature has also analyzed models in which aggregate fluctuations affect the level of output or the growth rate of output (Barlevy, 2004, den Haan and Sedlacek, 2013) and the effect of more general preference assumptions (Alvarez and Jermann, 2004, and Tallarini, 2000). Our paper contributes to this vast literature by taking the next step of analyzing how labor market reforms affect the welfare cost of business cycles.

Our paper is also related to the literature on labor market institutions and unemployment. This literature has studied extensively the effect of various labor market institutions on non-cyclical unemployment, but much less work has been done on the interaction between labor market institutions and macro shocks. Blanchard and Wolfers (2002) provide a comprehensive empirical study of the issue and Ljungqvist and Sargent (1998) use a search model to argue that the rise of unemployment rate in many European countries observed in the 1980s and 1990s can be explained by the interaction of a generous social insurance (welfare) system with a rise in market turbulence. More recently, Bentolila et al. (2012) and Jung and Kuhn (2012) use search and matching models to study to what extend labor

market institutions can explain the differences in worker flow volatilities between France and Spain, respectively Germany and the US. Finally, there is recent work using New Keynesian models with search and matching frictions in the labor market to discuss how labor market institutions affect output volatility and the design of monetary policy (see, for example, Christoffel, Kuester, and Linzert, 2009). These contributions have provided important insights into a number of issues. However, their focus has not been on welfare analysis, and an analysis of the interaction between labor market reform and the welfare cost of business cycles has so far been lacking.

There is also a large literature that analyzes the optimal path of unemployment insurance payments when search effort is unobservable (Hopenhayn and Nicolini, 1997, Pavoni, 2007, and Shimer and Werning, 2007). Work in this literature does not impose any prior restrictions on the class of unemployment insurance systems beyond incentive-compatibility and resource feasibility. In contrast, in the current paper we confine attention to a class of unemployment insurance systems that resemble actual unemployment systems and ask how parametric changes within this class affect the welfare costs of business cycles. Extending our approach to the study of more general unemployment insurance systems is an important topic for future research.

Finally, our paper is related to the economic literature on the German labor market reform of 2003-2005. There is a large empirical literature on this issue, which is surveyed in Sections 5 and the Appendix. Structural studies of the Hartz reforms based on macroeconomic search (and matching) models are surprisingly rare. Three notable exceptions are Launov and Waelde (2013), Krause and Uhlig (2012), and Krebs and Scheffel (2013), which are discussed in more detail in sections 5 and 6. Of these three contributions the paper by Krebs and Scheffel (2013) is most closely related to the current paper in the sense that they provide a welfare analysis of the Hartz reforms. However, Krebs and Scheffel (2013) do not consider cyclical variations in labor market variables and therefore cannot analyze the welfare cost of business cycles.

# 2. German Labor Market Reform 2003-2005

In this section we briefly review the German labor market experience since the 1970s and the German labor market reform implemented in 2003-2005, the so-called Hartz reforms. The Appendix provides a more detailed discussion of these reforms and the empirical evidence regarding their effects.

Figure 1 shows the unemployment rate in Germany in the period 1970-2012. The graph suggests that the German unemployment rate has a trend-component and a cyclical component, and that both have been affected by the Hartz reforms implemented in 2003-2005. Specifically, the trend component has been rising since the 1970s until the mid 2000s, and then started a secular decline that continued until the end of 2012. Further, the response of the German unemployment rate to the Great Recession was relatively mild compared to the cyclical increases of the German unemployment rate in previous recessions that occured before the Hartz reforms.

FIGURE 1 HERE

At the beginning of the 2000s, the dismal labor market performance and a tightening of the social security budget convinced the German government that a drastic policy reversal had to take place. As a consequence, the German government enacted in 2003-2005 a number of far-reaching labor market reforms, the so-called Hartz reforms. These reforms consisted of four laws that were implemented in three steps in January 2003 (Hartz I+II), January 2004 (Hartz III), and January 2005 (Hartz IV). The main objective of the Hartz reforms was simple yet ambitious: improve the process of moving workers from unemployment to employment.[6] In other words, these reforms mainly aimed at increasing the non-cyclical component of the job finding rate of unemployed workers. To achieve their objective, the

[6]The core elements of the reform were based on recommendations made by an expert commission that was headed by Peter Hartz, the Chief Human Resources Officer of Volkswagen at that time. In the preamble of the commission's report (Hartz et al 2002) this objective in combination with the idea of "challenge and promote" ("Fordern und Foerdern") are singled out as the most important principles guiding any reform effort.

reforms used a multi-layered strategy that had three core elements: i) increase the matching efficiency by improving job placement services, ii) increase labor supply by activating the unemployed, and iii) increase labor demand by deregulating the market for temporary work and providing employment subsidies. At the risk of over-simplification, we can say that Hartz III was mainly about the first point, Hartz IV was concerned with the second point, and Hartz I and II were mainly dealing with the last point. In this paper, we confine attention to Hartz III and Hartz IV.

On January 1, 2004, Hartz III was enacted with the goal to improve the efficiency of the job placement services for the unemployed. To this end, the Public Employment Agency was restructered and transformed from a strongly centralized and bureaucratic institution with little quality control into a decentralized, customer-oriented organization with a high degree of responsibility and accountability of local employment offices (called job centers after the reform). Further, in the wake of the reform many services were streamlined and heavy emphasis was placed on job search assistance to improve the process of matching unemployed workers with vacant jobs. In addition, the reform broke the de facto monopoly of the Public Employment Agency, which introduced competition in the market for job placement services. In particular, a voucher system was introduced providing individual job seekers with the opportunity to choose private placement agencies.[7]

The Hartz IV legislation was enacted in January 1, 2014, and constituted a radical overhaul of the German unemployment insurance system. Specifically, it focused on activating the unemployed and one of its main effects was to reduce the unemployment benefits paid to long-term unemployed (unemployment spell more than one year). To see this, we plot in figure 2 the net replacement rate for households with median labor income before the unemployment spell based on the OECD data (see the Appendix for more details on the construction of this variable). Clearly, Hartz IV had almost no effect on the net replacement

[7]The voucher system was already introduced in 2002 as part of the Job-AQTIV amendment, but Hartz III and Hartz IV subsequently allowed for a more wide-spread application of vouchers. The Job-AQTIV amendment in 2002 and Hartz I in 2003 also introduced the possibility that the Public Employment Agency outsources placement services to private providers (temporary work agencies).

rate of the short-term unemployed, but a very large effect on the net replacement rate of the long-term unemployed. Specifically, Hartz IV reduced the net replacement rate from 0.57 in the period 2000-2004 to 0.46 after the reform in 2005.

FIGURE 2 HERE

We note that a net replacement rate of 57 percent, the value for the long-term unemployed in Germany before the reform, is exceptionally high. In comparison, using the same methodology, we find a value of 27 percent in Spain and 38 percent in France for the long-term unemployed. Indeed, even after the reform, the net replacement rate for the long-term unemployed in Germany (46 percent) is still higher than in Spain (27 percent) and France (38 percent). In contrast, net replacement rates for short-term unemployed a very similar for all three countries: 68 percent for France, 66 percent for Spain, and 63 percent for Germany.

The empirical evidence suggests that the restructuring of the Federal Employment Agency in the wake of the Hartz III reform led to a substantial improvement in aggregate matching efficiency. There is also evidence that indicates that Hartz IV, by reducing the unemployment benefits of the long-term unemployed, increased search incentives and job finding rates. We survey the relevant literature in the Appendix. Here we only report the aggregate time series evidence. Specifically, in figure 3 we show quarterly job finding rates for the short-term unemployed and long-term unemployed over the period 2000-2013. The job finding rates for both groups have been relatively stable before implementation of these two reform packages and then began to rise steadily until the years 2007, at which stage they remained relatively stable at a significantly higher level.[8] For the long-term unemployed the average job finding rate in the period 2000-2003 is 6.3 percent and the average job finding rate in the period 2007-2012 is 9.3 percent. For the short-term unemployed the corresponding numbers are 24 and 37 percent, respectively. Thus, for both groups of unemployed individuals the job finding rate increased by about 50 percent, and the timing of the increase suggests that

[8]The analysis of Jung and Kuhn (2013) confirms that the German job finding rate is relatively stable over the business cycle, in contrast to the findings for the US economy (Shimer, 2005).

Hartz III and Hartz IV played an important role.

FIGURE 3 HERE

# 3. Model

This section develops the model and provides a convenient characterization of equilibrium. The model combines the tractable incomplete-market model of Krebs (2007) with a job search model along the lines of Hansen and Imrohoroglu (1992) and Ljungqvist and Sargent (1998).

### 3.1 Workers

Time is discrete and open ended. There is a unit mass of infinitely-lived workers. The employment status of a worker in period $t$ is denoted by $s_t$ and can take on three values, $s_t \in \{e, su, lu\}$, where $e$ stands for employed, $su$ for short-term unemployed, and $lu$ for long-term unemployed. Unemployed workers search for jobs and the job finding rate depends on individual search effort $l$ and the aggregate unemployment rate $U = U_{su} + U_{lu}$. We denote the job finding rate of the short-term unemployed by $\pi(e|su, U, l)$ and the job finding rate of the long-term unemployed by $\pi(e|lu, U, l)$. At the beginning of any unemployment spell, the household is short-term unemployed, and then becomes long-term unemployed with probability $\pi(lu|su)$. Employed households become unemployed with probability $\pi(su|e, S)$ (job destruction rate), which is independent of effort but depends on the state of the economy $S$. We assume that the aggregate state follows a Markov process with transition probabilities denoted by $\pi(S'|S)$. We denote the transition probabilities of the joint Markov process over individual and aggregate states by $\pi(s', S'|s, S, U, l)$.

We consider two types of labor market policy/institution and corresponding labor market reforms. The first type of policy/institution is defined by the structure of the Public Employment Agency affecting the quality of job placement services and therefore matching efficiency. This policy affects the job finding rates $\pi(e|su, l, U)$ and $\pi(e|lu, l, U)$ directly and its effect is summarized by an efficiency parameter $z$. For example, in Section 5 we use the

function $\pi(e|s,l,U) = z(s)\, l\, U^{\eta-1}$ for $s = su, lu$. This functional form for the job finding rate is in line with the matching function approach to the labor market assuming constant vacancy rates and an elasticity of job matching with respect to the unemployment rate that is equal to $\eta$ (Petrongolo and Pissarides, 2001).[9] We suppress the dependence of these transition probabilities on the parameter $z$ until we return to the discussion of labor market reform in Section 4.2. For simplicity, we set the cost of providing job search assistance to zero.

The second type of policy/institution analyzed in this paper is the unemployment insurance system. The level and duration of unemployment benefit payments do not affect job finding rates directly, but have an indirect impact through their effect on search effort $l$. We next turn to a discussion of the unemployment insurance system.

Employed workers receive labor income $(1-\tau)wh_t$, where $w$ is the wage per unit of human capital and $\tau$ is a linear tax on labor income (social security tax). Unemployed workers receive unemployment benefits $b(s_t)h_t$ with $s_t = su, lu$. For tractability reasons, we also assume that unemployment benefit payments depend on the current human level of human capital. At the beginning of life, worker have no financial wealth but they can save at the risk free rate $r_t$ and borrow at the rate $r_t + \varphi$, where $\varphi$ is an exogenous cost of financial intermediation. Thus, workers' budget constraint reads

$$a_{t+1} = \begin{cases} (1+r_t)a_t + (1-\tau)wh_t - c_t & if\ a_{t+1} \geq 0\ and\ s_t = e \\ (1+r_t)a_t + b(s_t)h_t - c_t & if\ a_{t+1} \geq 0\ and\ s_t = su, lu \\ (1+r_t+\varphi)a_t + (1-\tau)wh_t - c_t & if\ a_{t+1} < 0\ and\ s_t = e \\ (1+r_t+\varphi)a_t + b(s_t)h_t - c_t & if\ a_{t+1} < 0\ and\ s_t = su, lu \end{cases}$$

$$h_{t+1} = (1+\epsilon(s_t, s_{t+1}))h_t \tag{1}$$

Note that the exogenous process of human capital (skills) defined in (1) defines in conjunction with the wage rate the labor income process.

[9] Petrongolo and Pissarides (2001) suggest that $U \times L$ instead of $U$ should enter the matching function, where $L$ is the average search effort chosen by unemployed workers. In Section 6 we consider an extension of the model with this type of matching function.

Workers are risk-averse and have identical preferences that allow for a time-additive expected utility representation. The one-period utility function depends on consumption, search effort, and the employment status. We confine attention to utility functions that are logarithmic over consumption: $u(c, l, s) = \ln c - d(l, s)$, where $d$ is an increasing and strictly convex function in $l$. Expected life-time utility associated with a consumption-effort plan, $\{c_t, l_t\}$ for a worker with initial employment status $s_0$ is given by

$$U(\{c_t, l_t\}) \;=\; E\left[\sum_{t=0}^{\infty} \beta^t \left(\ln c_t - d(l_t, s_t)\right) | s_0\right] \tag{2}$$

where $\beta$ is the pure discount factor of workers. Note that the expectations in (2) is taken with respect to joint distribution over idiosyncratic and aggregate shocks that depends through the transition probabilities $\pi$ on the effort choice $\{l_t\}$. For notational ease we suppress this dependence.

Workers choose a plan $\{c_t, l_t, a_t\}$ so as to maximize (2) subject to (1).

### 3.2 Firms

The consumption good is produced using the production function $Y_t = AN_t$, where $Y_t$ is aggregate output in period $t$, $N_t$ is the aggregate stock of effective labor employed in production (the human capital stock of employed households), and $A$ is a productivity parameter. Firms hire labor in competitive labor markets and the real wage adjusts so that equilibrium profit is zero: $A = w$.

### 3.3 Equilibrium Definition

Define the aggregate stock of human capital of worker of type $s$ as $H_{t,s} = E[h_t | s_t = s]$ with $s = e, su, lu$. Note that we have $H_t = H_{t,e} + H_{t,su} + H_{t,lu} = E[h_t]$. Labor market clearing requires that labor hired by firms, $N_t$, is equal to the aggregate labor supply, $H_{t,e} = (1 - U_t)H_t$. We assume that the risk-free asset is in zero net supply. Thus, market clearing in the labor market and the asset market reads:

$$N_t \;=\; (1 - U_t)H_t \tag{3}$$

$$E_t[a_t] \;=\; 0$$

where the expectation in (3) is taken over all individual histories $s^t$ conditional on the history of aggregate shocks $S^t$.

We assume that the government runs a balanced budget in expected value terms (on average). To define this budget constraint, let $\Omega_{t,s} = H_{t,s}/H_t$ the human capital share of workers of type $s$ in period $t$ with $s = e, su, lu$. Below we show that in equilibrium $\Omega$ is the solution to a recursive equation. Let $\Omega^*$ be the stationary point of this recursive equation – the vector of human capital shares in steady state. We impose the following government budget constraint:

$$\tau w \Omega^*(e) \;=\; b(su)\Omega^*(su) + b(lu)\Omega^*(lu) \tag{4}$$

Our assumption that labor market policy, described by the policy parameters $\tau$, $b(su)$, and $b(lu)$, does not react to aggregate shocks, $S$, is motivated by our desire to introduce a clear distinction between labor market reform and macroeconomic stabilization policy. Specifically, we define labor market reform as any change in the non-cyclical policy parameters $\tau$, $b(su)$, $b(lu)$ and the non-cyclical efficiency parameter $z$. In contrast, macroeconomic stabilization policy is defined as cycle-dependent policies that affects the properties of the cyclical job destruction rate (see below). In this sense papers by Landais, Michaillat, and Saez (2010) and Jung and Kuester (2013), who analyze the optimal choice of $S$-dependent unemployment benefit rates, deal with macroeconomic stabilization policy, not labor market reform.

The assumption that labor market policy is non-cyclical implies that the government budget is in general not balanced and that government debt varies over time. Indeed, it is straightforward to show that the implied path of government debt does not satisfy the standard solvency constraint (Bohn, 1995) for all histories of aggregate shocks. In our robustness section we therefore consider a version of the model with tax rates $\tau$ that react to high levels of debt so that the government solvency constraint is satisfied. We find that the effect of this change on the main results is quantitatively small.

A (sequential) competitive equilibrium is defined in the standard manner:

**Definition** For given government policy $(b, \tau)$, a competitive equilibrium is a wage rate $w = A$, a sequence of interest rates, $\{r_t\}$, and a worker plan, $\{c_t, a_t, l_t\}$, so that

i) for given wage rate $w$ and sequence of interest rates $\{r_t\}$, the individual plan $\{c_t, a_t, l_t\}$ maximizes expected lifetime utility (2) subject to (1).

ii) Market clearing condition (3) holds in each period $t$.

A budget feasible government policy is a $(b, \tau)$ satisfying the government budget constraint (4).

### 3.5 Equilibrium Characterization

The recursive formulation of workers' maximization problem reads

$$\begin{aligned} V(a,h,s,S,U) \quad &= \quad \max_{c,l,a'} \left\{ \ln c - d(l,s) + \beta \sum_{s',S'} V(a',h',s',S',U')\pi(s',S'|s,l,S,U) \right\} \\ &s.t. \quad (a',c) \in \Gamma(a,h,s,S,U) \\ &\qquad h' = (1+\epsilon(s,s'))h \\ &\qquad U' = \Phi(U,S) \end{aligned} \tag{5}$$

where $\Gamma$ is the correspondence defined by the individual budget set (1) and $\Phi$ is the (endogenous) equilibrium law of motion for the unemployment rate $U$. Note that the effort choice $l$ is only relevant if $s = su, lu$.

In the Appendix we show that under certain conditions there is an equilibrium in which workers choose asset holdings $a_t = 0$ and consumption $c_t = \phi(s_t)h_t$ for all histories (for all states), where we define $\phi(e) = (1-\tau)w$ and $\phi(s) = b(s)$ for $s = su, lu$. In other words, there is no trade in financial assets and consumption equals income (after-tax earnings or unemployment benefits). The equilibrium interest rate supporting the equilibrium allocation

is determined by the intertemporal marginal rate of substitution of employed workers

$$1 + r(S) \;=\; \frac{1}{\beta}\left(\sum_{s'} \frac{\phi(e)}{\phi(s')(1+\epsilon(e,s'))}\pi(s'|e,S)\right)^{-1} \tag{6}$$

Equation (6) ensures that $a_t = 0$ is an optimal choice for employed workers. To ensure that unemployed workers have no incentive to save or borrow, the transaction cost $\varphi$ has to be at least as large as

$$\begin{aligned}\varphi_{min} \;&=\; \max_{S,U}\left\{\frac{1}{\beta}\left(\sum_{s'} \frac{\phi(su)}{\phi(s')(1+\epsilon(su,s'))}\pi(s'|su,l(su,S,U),S,U)\right)^{-1}\right. \\ &-\; \left.\frac{1}{\beta}\left(\sum_{s'} \frac{\phi(e)}{\phi(s')(1+\epsilon(e,s'))}\pi(s'|e,S)\right)^{-1}\right\}\end{aligned} \tag{7}$$

where $l(su,S,U)$ is the equilibrium effort choice of short-term unemployed workers specified below. In this characterization we assume that employed workers have the strongest incentive to save and short-term unemployed workers have the strongest incentive to dissave. The equilibrium characterization for the other cases is accordingly.

The value function of workers in equilibrium at $a_t = 0$ can easily be computed and is given by

$$V(0,h,s,S,U) \;=\; v(s,S,U) + \frac{1}{1-\beta} ln\, h \tag{8}$$

where $v$ together with the optimal effort choice are the solution to the intensive-form Bellman equation

$$\begin{aligned}v(s,S,U) \;&=\; \max_l \left\{\ln\phi(s) - d(l,s) + \frac{\beta}{1-\beta}\sum_{s'}\ln(1+\epsilon(s,s'))\pi(s'|s,S,U,l)\right. \\ &\quad \left.+\beta\sum_{s',S'} v(s',S',U')\pi(s',S'|s,S,U,l)\right\} \\ &\quad U' \;=\; \Phi(U,S)\end{aligned} \tag{9}$$

The solution to equation (9) defines the equilibrium effort choice of workers. We further have $a_t = 0$ and $c_t = \phi(s_t)h_t$ with $h_{t+1} = (1+\epsilon(s_t,s_{t+1}))h_t$ in equilibrium, which implies that the solution to (9) also defines the equilibrium plan $\{c_t, a_t, l_t\}$ of workers. The law of

motion for the aggregate human capital stock and for the aggregate human capital shares becomes:

$$H'_{s'} = \sum_{s}(1+\epsilon(s,s'))\pi(s'|s,S,U,l(s,S,U))H_s \tag{10}$$

$$\Omega'_{s'} = \frac{\sum_s(1+\epsilon(s,s'))\pi(s'|s,S,U,l(s,S,U))\Omega_s}{\sum_{s,s'}(1+\epsilon(s,s'))\pi(s'|s,S,U,l(s,S,U))\Omega_s}$$

$$U_{s'} = \sum_{s=su,lu} \pi(s'|s,U,l(s,S,U))\,U_s \;+\; \pi(s'|e,S)(1-U_{su}-U_{lu})$$

**Proposition 1.** Suppose that the cost of financial intermediation $\varphi$ is greater or equal to $\theta_{min}$ given in (7). Then the solution to (9) and (10) defines a recursive equilibrium.

*Proof*: Appendix.

# 4. Cost of Business Cycles

We now turn to the analysis of the interaction between labor market reform and the cost of business cycles. In section 4.1 we discuss how to eliminate business cycles in our framework. Section 4.2 derives a useful formula for the cost of business cycles and shows that under certain conditions an increase in matching efficiency or a reduction in unemployment benefits (labor market reforms) reduce the welfare cost of business cycles.

### 4.1 Eliminating Business Cycles

We follow Lucas (1987, 2003) and analyze the welfare consequences of macroeconomic stabilization policy without having an explicit model of the interaction between stabilization policy and the business cycle. As in Lucas (1987, 2003) we consider a thought experiment in which stabilization policy completely eliminates business cycles, that is, we consider moving from an economy with $S$-dependent labor market risk $\pi$ and $\epsilon$ to an economy with labor market risk $\hat{\pi}$ and $\hat{\epsilon}$ that is independent of business cycle conditions $S$. The question that arises is how to find $\hat{\pi}$ and $\hat{\epsilon}$ given $\pi$ and $\epsilon$.

For economies without idiosyncratic risk Lucas (1987, 2003) postulates that the elimination of business cycles amounts to replacing all $S$-dependent random variables by their expected value. Krebs (2003), Krusell and Smith (1999), and Krusell et al. (2009) extend this principle to economies with idiosyncratic risk by taking the expected value conditional on each possible individual state $(s, s')$:

$$\hat{\epsilon} \;=\; E[\epsilon|s, s'] \tag{11}$$

In our model economy only the transition probabilities $\pi(s'|e, S)$ with $s' = su, e$ depend on the aggregate state $S$ – only job destruction rates have a cyclical component. Thus, the integration principle (11) reads

$$\begin{aligned} \hat{\pi}(s'|e) &= \sum_{S} \pi(s'|e, S)\alpha(S|e) \\ \hat{\pi}(s'|s, l, U) &= \pi(s'|s, l, U) \quad s = su, lu \\ \hat{\epsilon}(s, s') &= \epsilon(s, s') \end{aligned} \tag{12}$$

where $\alpha(S|e)$ is a general weighting distribution that captures the nature of macroeconomic stabilization policy. A common approach in the literature (Krebs, 2003 and 2007, Krusell and Smith, 1999, and Krusell et al., 2009) is to use a weighting distribution $\alpha(S|e) = \pi(S|e)$, where $\pi(S|e) = \pi(e, S)/\pi(e)$ is the stationary distribution associated with the transition function $\pi(s', S'|s, S)$. In our case this means that stabilization policy removes the fluctuations in job destruction rates without affecting the mean of the job destruction rate. However, there are reasons to believe that this approach is too restrictive (see below), and in this paper we therefore consider all possible weighting distributions $\alpha(S|e)$ allowing for the possibility that stabilization policy has asymmetric effects on the labor market (job destruction rates).

In the baseline model we consider the case of two aggregate states: $S = R, B$ (recession and boom). For this case, the effect of stabilization policy is given by

$$\alpha(S|e) \;=\; \begin{cases} (1-\alpha)\pi(R|e) & if\ S = R \\ \pi(B|e) + \alpha\pi(R|e) & if\ S = B \end{cases} \tag{13}$$

The parameter $\alpha$ controls the degree of asymmetry of stabilization policy. If $\alpha = 0$, stabilization policy has a fully symmetric effect in recessions and booms. This is the case considered by Krebs (2003, 2007), Krusell and Smith (1999), and Krusell et al. (2009) and implies in our setting that stabilization policy removes the volatility of the job destruction rate without affecting its mean. In contrast, for $\alpha > 0$ stabilization policy removes the volatility in the job destruction rate and reduces its mean. If $\alpha = 1$ we have the extreme scenario in which stabilization policy removes the labor market effects of recessions without affecting the labor market in boom times. In this case, $\Delta$ is identical to the welfare cost of recessions. Note that this cost is similar to the cost of recession computed in Hall (1995) and Davis and Wachter (2011), but not the same. Hall (1995) and Davis and Wachter (2011) compute the cost of one recession, whereas in this paper we are concerned with the cost of all (future) recessions.

There are at least three reasons why $\alpha > 0$ is a plausible case. First, Auerbach and Gorodnichenko (2012) provide empirical evidence that fiscal multipliers are substantially larger in recessions than in booms. If output and job destruction rates are positively correlated, then this finding implies that stabilization policy has an asymmetric effect on the labor market and can change the average job destruction rate. In line with this empirical finding, Gali, Gertler, and Lopez-Salido (2007) show that in a simple New-Keynesian model efficiency losses due to mis-pricing during a recession are not offset by the efficiency gains in a boom. Second, Beaudry and Pages (2001) provide a theoretical argument that implicit contracts lead to an asymmetric response of the labor market, though they focus on the earnings losses of displaced workers. Third, papers by Further, Hairault, Lagot, and Osotimehim (2010) and Jung and Kuester (2011) have shown that in standard search and matching models a mean-preserving reduction in the volatility of aggregate productivity shocks reduces the mean of the unemployment rate. In the Appendix we discuss in more detail the conditions under which an elimination of fluctuations in productivity shocks decreases the mean of the job destruction rate in search and matching models.

Equation (12) shows how stabilization policy affects job destruction rates, but it leaves open the question how to adjust the policy parameters $\tau$, $b(su)$, and $b(lu)$ so that the

government budget constraint (4) continues to hold. Clearly, there are different ways of adjusting $(\tau, b(su), b(lu))$, corresponding to different ways of distributing the gains from stabilization policy, all satisfying the government budget constraint (4). For the baseline model, we assume that in response to stabilization policy the social security tax, $\tau$, adjusts. In the quantitative section we conduct a robustness analysis with respect to alternative assumptions.

### 4.2 Welfare Cost of Business Cycles

Let $\Delta$ stand for the welfare cost of business cycles. We define this welfare cost as the ex-ante welfare difference, expressed in lifetime consumption units, between living in an economy with business cycles (recessions) and an economy without business cycles (recessions). Here we use ex-ante in the sense of not knowing the initial values of $(s_0, S_0)$, but conditional on $h_0$. Denote by $\hat{V}(h_0, s_0)$ the value (lifetime utility) of living in an economy without business cycles for a workers with initial state $(h_0, s_0)$. Similarly, denote by $V(h_0, s_0, S_0, U_0; \Delta)$ the value (expected lifetime utility) of living in an economy with business cycles when the initial aggregate state is $S_0$ for an individual worker with initial state $(h_0, s_0)$ who receives a consumption subsidy $\Delta$ so that his consumption in equilibrium is $c_t = (1 + \Delta)\phi(s_t)h_t$ in every period. We define the welfare cost of business cycles $\Delta$ as the solution to the equation

$$\sum_{s_0, S_0} \int_{U_0} V(h_0, s_0, S_0, U_0; \Delta) d\pi(U_0, s_0, S_0)\mu(s_0) = \sum_{s_0} \hat{V}(h_0, s_0)\hat{\pi}(s_0)\mu(s_0) \tag{14}$$

where $\pi(.)$ is the implied stationary distribution over $(s, S, U)$ in the economy with business cycles and $\hat{\pi}(.)$ is the implied stationary distribution in the economy without business cycles.

In (14) we have introduced a weighting measure $\mu$ reflecting the weights of individual types $s$ in the social welfare function. We assume that the welfare weights are non-negative, $\mu(s_0) \geq 0$, and that satisfy the normalization condition $\sum_{s_0} \pi(s_0)\mu(s_0) = 1$. If $\mu(s_0) = 1$ for all $s_0$, then all worker-types have equal weight and we have the standard utilitarian welfare function commonly used in macroeconomics. In this paper, we also consider the case of type-dependent weights – the case of generalized utilitarian welfare function in the language of Blackorby, Bossert, and Donaldson (1999). This assumption allows for a more

general welfare analysis than the one usually conducted in quantitative macroeconomics. In particular, the quantitative application in Section 6 shows that the effect of labor market reform on the cost of business cycles becomes stronger when the social planner puts more weight on unemployed workers. The assumption that the social planner puts more weight on unemployed than employed workers is in line with the idea that in policy discussions the main argument in support of macroeconomic stabilization policy is that it helps the unemployed.[10]

Our equilibrium characterization result (proposition 1) allows us to compute equilibrium consumption for given fundamentals and our method of eliminating business cycles (12) specifies the fundamentals for the economy without business cycles. Using the value function defined by (8) and (9) the welfare cost of business cycles can be written as

$$\ln(1+\Delta) \;=\; (1-\beta)\left[\sum_{s_0}\hat{v}(s_0)\hat{\pi}(s_0)\mu(s_0) - \sum_{s_0,S_0}\int_{U_0} v(s_0,S_0,U_0)d\pi(U_0,s_0,S_0)\mu(s_0)\right] \quad (15)$$

Equation (15) shows that the welfare cost of business cycles is independent of the initial human capital stock $h_0$, a result that is a direct consequence of our assumption of homothetic preferences and skill shocks (depreciation rates during unemployment) that are proportional to the stock of human capital. Equation (15) provides a convenient formula that allows for a transparent discussion of the impact of labor market reform on the cost of business cycles. Of course, the equilibrium value function as well as the equilibrium distributions depend on equilibrium effort choices $l$, respectively $\hat{l}$, through their dependence on the transition probabilities $\pi(s',S'|s,S,U,l)$, respectively $\hat{\pi}(s'|s,l)$. Further, labor market reforms that change matching efficiency $z$ (Hartz III) and/or unemployment benefits $b(lu)$ (Hartz IV) have an impact on $\Delta$ through their direct effect on $v$ and $\pi$ and their indirect effect via equilibrium effort choices.

[10]The social welfare function (14) has standard properties for fixed population weights $\pi$, but for changes in population weights $\pi$ the function (14) can have undesirable implications depending on the normalization. The importance of normalizing utility is well-known in social choice theory dealing with changing population size (Blackorby, Bossert, and Donaldson, 1999). In our case, the social welfare function (14) and the welfare cost of business cycles (15) satisfy all standard properties if $v(s) < 0$ for $s = su, lu$, which is satisfied in our calibrated model economy.

To gain additional insight into the determinants of $\Delta$, consider the case with only one unemployment state: $s = u, e$. Suppose further that the social planner only cares about the unemployed, $\mu(e) = 0$, and that their is only one unemployment state, $s = u$. In this case equation (15) becomes

$$\ln(1+\Delta) \;=\; (1-\beta)\left[v(u)\Delta\pi(u) \;+\; \Delta v(u)\hat{\pi}(u)\right]\mu(u) \tag{16}$$

where $\Delta\pi(u) \doteq \hat{\pi}(u) - \pi(u)$ and $\Delta v(u) \doteq \hat{v}(u) - v(u)$. Equation (16) shows that the gains from stabilization policy is the sum of two terms. The first term measures the gain that comes through a reduction in the average unemployment rate and the second term measures the utility gain of unemployed workers. Labor market reform reduces both terms. Specifically, an increase in matching efficiency (Hartz III) or a reduction in unemployment benefits (Hartz IV) increases job finding rates and reduces steady state unemployment, which in turn reduces the potential for reducing unemployment further through stabilization policy. This reduces the first term in equation (16). An increase in matching efficiency also reduces the individual gain, $\Delta v$, that comes from the elimination of business cycles. Thus, Hartz III also reduces the second term in equation (16). The same holds for a reduction in unemployment benefits (Hartz IV) if unemployment benefits are too high before the reform. The following proposition states more formally the result:

**Proposition 2.** Suppose that the social planner mainly cares about unemployed workers in the sense that $\mu(e)$ is small. Then an increase in matching efficiency reduces the welfare cost of business cycles (the gains from macroeconomic stabilization policy):

$$\frac{\partial\Delta}{\partial z} \;<\; 0$$

Suppose that unemployment benefits are too high in the sense that $\frac{\partial v(u)}{\partial b} < 0$. Then a reduction in unemployment benefits reduces the welfare cost of business cycles

$$\frac{\partial\Delta}{\partial b} \;>\; 0$$

*Proof*: Appendix.

# 5. Model Specification and Calibration

In this section, we specify a baseline model and calibrate the model economy in order to match a number of facts of the German labor market before the Hartz reforms. In particular, the model economy matches some of the key features of the German unemployment insurance system before the reform and the unemployment benefit elasticity of individual job finding rates (search intensity). We also require the model economy to match the values of a number of macro variables (unemployment rate, flows in and out of unemployment) in the stationary equilibrium of the calibrated model economy – sections 5.2-5.5 deal with this part of the calibration. Finally, in section 5.6 we calibrate the parameters of the stochastic job destruction process to match the cyclical properties of separation rates (flow rates from employment into unemployment) in Germany and discuss the cyclical properties of the implied job finding rates.

Our calibration strategy requires us to find the long-run values of a number of macro variables before the reform. We use two methods to find these long-run values. The first method computes from the data the average value in the period 2000-2004. The second method is to apply the HP-filter to the data in the period until 2005, and then to take the value of the long-run trend in year 2002. Both methods yield almost identical results and we therefore report only the results using the first method. However, it is conceivable that alternative methods could produce very different target values. We therefore return to the issue of finding long-run values from the data in our robustness analysis in section 6.3, where we report how our main results change if we choose target values that differ substantially from the ones chosen here.

### 5.1 Model Specification

The basic model period is one quarter. We assume a two-state aggregate shock process $S \in \{R, B\}$, where $R$ stands for recession (high job destruction rate) and $B$ for boom (low rate of job destruction). We further assume $\epsilon(s, s') = \epsilon(s')$ and denote skill depreciation of the short-term unemployed and long-term unemployed by $\epsilon(su) = \delta_{h,su}$ and $\epsilon(lu) = \delta_{h,lu}$,

respectively. For the baseline calibration, we assume $\delta_{h,su} = \delta_{h,lu}$. We use the standard OECD convention and define long-term unemployment as any unemployment spell that lasts longer than 12 months. Thus, we choose the probability $\pi(lu|su)$ of transiting from $su$ to $lu$ equal to 0.25.

### 5.2 Search and Job Finding Rates

For the job search technology we assume a linear function:

$$\begin{aligned} \pi(e|su,l) &= z(su)\, l\, U^{\eta-1} \\ \pi(e|lu,l) &= z(lu)\, l\, U^{\eta-1}\,, \end{aligned} \tag{17}$$

where $U = U(su) + U(lu)$. This functional form for the job finding rate is in line with the matching function approach to the labor market assuming constant vacancy rates and an elasticity of job matching with respect to the unemployment rate that is equal to $\eta$. See Petrongolo and Pissarides (2001), who survey the relevant theoretical literature and discuss the empirical studies estimating $\eta$. For Germany, Burda and Wyplosz (1994) find a value of $\eta = 0.68$ and we use this value for our baseline calibration.

We choose the values of $z(su)$ and $z(lu)$ so that the corresponding job finding probabilities match the observed average transition rates in the period 2000-2004 for the short-term unemployed and long-term unemployed, respectively. The values for the quarterly transition probabilities are $\pi(e|lu) = .06$ and $\pi(e|su) = .24$ according to the data provided by the Federal Employment Agency (Bundesagentur fuer Arbeit), which yields $z(su) = 0.1275$ and $z(lu) = 0.0715$.

We assume that dis-utility of search is

$$d(l,s) \;=\; d_0\, l^{\gamma} - d_1(s) \tag{18}$$

For the employed workers, we set the disutility of work, $d_1(e)$, equal to the value assumed in the standard real business cycle model with log utility (Prescott and Hansen, 1995). It is well-known that with the above specification the parameters $\lambda(su)$, $\lambda(lu)$ and $d_0$ are not

separately identified. We therefore choose a numerically convenient normalization of $d_0 = 1$. We choose $d_1(su)$ and $d_1(lu)$ so that the value of the disultility term $d$ in equilibrium is the same for employed workers, short-term unemployed workers, and long-term unemployed workers. We choose the curvature parameter $\gamma$ to match a given value of the elasticity of the job finding rate with respect to benefits payments for the short-term unemployed, where we choose as target the micro elasticity holding constant the labor market state $U$. This target elasticity is chosen as follows.

For the US, there are a number of empirical micro studies estimating the search elasticity directly. The best known studies are Moffitt (1985) and Meyer (1990) who estimate an elasticity of around $-0.9$. Krueger and Meyer (2002) survey the literature and suggest an elasticity of $-1$. There is much less work on this issue for Germany, but Hunt (1995) finds estimates for Germany that are similar to the US results. Consistent with this finding are the results reported in Hofmann (2012) and Mueller and Steiner (2008), who find that imposing benefit sanctions on long-term unemployed for non-compliance has significant effects on the unemployment-to-employment transition in Germany. Addison, Centeno and Portugal (2008) use a structural search model and the European Community Household Panel (ECHP) to estimate the elasticity for several European countries, and they find values ranging from -1.14 to -1.66 for Germany. Almost all empirical studies deal with unemployed workers who are short-term unemployed according to our definition (less than one year of unemployment). In our baseline calibration, we choose a target elasticity of $-0.5$ for the short-term unemployed, a conservative value for the German labor market given the available empirical evidence.

Landais, Michaillat, and Saez (2010) have argued that macro elasticities can be smaller than micro elasticities due to labor demand externalities. Several papers have tried to estimate this labor-demand externality, but the empirical literature has not reached a consensus. For example, Blundell et al. (2004) find no spillover effect in the UK, but Crepon et al. (2013) estimate a reduction of 37 percent for young French job seekers. The macro elasticity can also be larger than the micro elasticity if there are wage externalities (Landais et al., 2010)

or if job destruction is endogenous.[11] Indeed, Hagedorn, Karahan, Manovskii, and Mitman (2013) provide empirical evidence that the macro elasticity is substantially larger than the micro elasticity due to effect of unemployment benefits on job creation. In Section 5.3 we discuss the robustness of our quantitative results to alternative assumptions about the target elasticity.

Our calibration implies an elasticity of unemployment duration with respect to unemployment benefits for the long-term unemployed of $-0.6$, which is somewhat larger than the corresponding elasticity for the short-term unemployed. We are not aware of any study that estimates this elasticity separately for the short-term and long-term unemployed. However, work by Chetty (2008) shows that the effect of unemployment benefits on unemployment duration is much stronger for low-wealth individuals, an effect he calls the liquidity effect based on the assumption that low-wealth individuals are liquidity constrained. In the data and in our model the long-term unemployed are the low-wealth individuals. Indeed, in Germany unemployment insurance for the long-term unemployed (Unemployment Benefits II) is means-tested with very low levels of permissable asset holdings. The estimates reported in Chetty (2008) suggest that the elasticity of the long-term unemployed (low-wealth unemployed) is substantially larger than the search elasticity of the short-term unemployed.

We also allow for transitions from long-term unemployment to short-term unemployment. We choose the transition probability $\pi(su|lu)$ to match a given fraction of long-term unemployed in the unemployment pool. According to the OECD statistics, the share of long-term unemployment was 50 percent for the period 2000-2004, a value we match if $\pi(su|lu) = 0.190$.

### 5.3 Job Separation

We choose an average job separation rate, $\pi(su|e) = \sum_S \pi(su|e,S)\pi(S|e)$, so that the implied steady state unemployment rate is equal the average unemployment rate in the

[11] Landais et la. (2010) also argue that the elasticity wedge is counter-cyclical, and Crepon et al. (2013) provide evidence supporting this view. Below we discuss the cyclical properties of the elasticity implied by our calibrated model economy.

period 2000-2004, namely 10 percent. This yields a steady state job separation rate of $\pi(e|su) = 0.0159$, which is in line with Jung and Kuhn (2013).

### 5.4 Skill Loss During Unemployment

There is substantial empirical evidence that job loss leads to subsequent lower wages and earnings, and that these wage losses increase with the duration of unemployment. For the US, Addisson and Portugal (1989) use data drawn from the Displaced Worker Survey and find that an increase in the unemployment duration by 10% reduces wages between 0.8% and 1.4%. Using the same data, Neal (1995) finds that an additional week of unemployment reduces the wages by 0.37%, implying a monthly rate of wage loss of 1.5%. Further, using a structural approach Keane and Wolpin (1997) estimate high rates of skill depreciation during unemployment. For Germany, Schmieder, Wachter, and Bender (2013) use a large administrative data set to implement a regression discontinuity (RD) design and find that each month out of work reduces reemployment wages by 0.8 percent, pointing to substantial costs of long unemployment spells. In this paper, we interpret the duration dependence of wage losses as arising from skill depreciation during unemployment. Guided by the findings of the empirical literature, we set the skill depreciation parameter, $\delta_{h,su} = \delta_{h,lu}$, to a quarterly depreciation rate of 2.5%.

The work by Schmieder, Wachter, and Bender (2013) on skill losses allows for job search and wage offers that change with unemployment duration, which makes their results directly applicable to our setting. The finding of substantial skill depreciation during unemployment is consistent with recent empirical results pointing to a negative effect of unemployment benefits on re-employment wages (Card, Chetty, and Weber, 2007). Note that these empirical studies estimate wage effects that already take into account the possibility that unemployment benefit duration affects match quality (Acemoglu and Shimer, 1999).

For the US labor market, there is also empirical evidence that earnings losses due to job displacement increase substantially during recessions. This fact has been first documented by Jacobson, Sullivan, and (1993) and has been confirmed subsequently by a number of

studies, most recently by Davis and Wachter (2011). Such cyclicality in earnings losses can arise even with a-cyclical skill depreciation rates because unemployment duration increases during recessions, but given that job finding rates in Germany are only mildly cyclical the implied cyclical variation in earnings losses is small for our calibrated model economy (see below). This implication of our model economy, however, is not inconsistent with the empirical evidence for Germany. Specifically, there is little work on the cyclical properties of wage losses associated with job displacement in Germany, and the work that has been done (Burda and Mertens, 2001) suggests that earnings losses are mildly cyclical, but the estimates are too imprecise to draw any firm conclusions. Note also that incorporating additional cyclicality of earnings losses will most likely re-enforce our main result since it leads to larger welfare cost of business cycles (Krebs, 2007).

### 5.5 Unemployment Benefits

We choose the unemployment benefit parameters $b(su) = w$ so that consumption of the short-term unemployed only changes because of the loss of human capital (perfect consumption smoothing of transitory income shocks). We choose the unemployment benefit parameter $b(lu)$ to match the difference in the net replacement rate of the short-term unemployed and long-term unemployed (the change that occurs when moving from short-term unemployment to long-term unemployment).[12] The OECD reports the net replacement rate for short-term and long-term unemployed, where long-term unemployment is defined as unemployment duration longer than one year. The Hartz IV reform clearly had different effects on different sub-groups of the short-term and long-term unemployed. However, neither the model nor the OECD data are detailed enough to capture all aspects of this heterogeneity. We therefore focus on net replacement rates of single households with median earnings before the job loss. The OECD reports the net replacement rate for two subgroups of this group of households, namely single households without children and single households with two children. We calibrate the parameter $b(lu)$ so that the model matches the weighted average net replacement

[12]In the model, the net replacement rate is not $b$, but $b/((1-\tau)r_h)$, and we choose $b$ so that the implied value of $b/((1-\tau)r_h)$ matches the corresponding net replacement rate.

rate for these two groups, where the weight for the first group is set equal to the population weight of all households without children and the weight of the second group is set equal to the population weight of all households with children. For the period 2000-2004, this yields a net replacement rate of 0.63 for the short-term unemployed and 0.57 for the long-term unemployed – see figure 2.[13]

### 5.6 Cyclical Variation

Jung and Kuhn (2013) report estimates of quarterly job separation rates and job finding rates for Germany for the period 1980-2005. We use their estimates and detrend the time series using a HP filter. See figures 4 and 5 for the resulting flow rates into and out off unemployment expressed as percentage deviation from the HP-trend. We then compute standard deviation and serial correlation of the detrended series of job separation and choose the model parameters to match these two empirical moments. Specifically, for the $2 \times 2$ transition matrix $\pi(S'|S)$ we make the symmetry assumption $\pi(B|B) = \pi(R|R)$ so that there is only one free probability parameter and the implied stationary distribution is $\pi(B) = \pi(R) = 1/2$. The probability parameters $\pi(B|B) = \pi(R|R)$ is then determined by the target value of the serial correlation coefficient of the job separation rate, and two values of the job destruction rate, $\pi(su|e, R)$ and $\pi(su|e, B)$, are determined by the target values for the mean and standard deviation. The resulting empirical moments are a mean of 0.0159 (see section 5.3), a standard deviation of 0.0019, and a quarterly serial correlation of 0.865. The corresponding parameter values are $\pi(B|B) = \pi(R|R) = 0.93$, $\pi(su|e, R) = 0.0181$ and $\pi(su|e, B) = 0.0144$.

FIGURES 4 AND 5 HERE

[13]The results are similar, at least in terms of the effect of Hartz IV on net replacement rates, if we take couples instead of singles as long as we weigh the group without children and the group with two children the same way. The OECD does not report net replacement rates for households with one child. Hartz IV had a larger effect on the net replacement rate of households with one child than it had on the net replacement rate of households with two children, and our weighing scheme therefore understates the effect of Hartz IV on net replacement rates.

We do not target the cyclical properties of the job finding rate. We find that both in the model and in the data job finding rates decline during recessions. In the model, the decline in the job finding rate during recessions is driven by the increase in the unemployment rate leading to a congestion effect through the matching function. Further, the volatility (standard deviation) of the job finding rate in the model matches the empirical volatility well: a standard deviation of 5.5 percent according to the model and a standard deviation of 6.8 percent in the data. This suggests that our model captures te main mechanism behind the cyclical variation in job finding probabilities in Germany.

# 6. Quantitative Results

In this section we present the quantitative results. Section 6.1 discusses who to map the two labor market reforms, namely the restructuring of the Public Employment Agency (Hartz III) and the reform of the unemployment insurance system (Hartz IV), into the model parameters. Section 6.2 provides a discussion of our main quantitative results and Section 6.3 concludes with a robustness analysis.

### 6.1 Labor Market Reform in the Model

The evidence reviewed in the Appendix shows that the restructuring of the Public Employment Agency (Hartz III) increased the efficiency parameter of the aggregate matching function by at least 5 percent and perhaps up to 10 percent. The evidence also suggests that the introduction of vouchers for placement services improved the job finding rate of affected workers by about $10-30$ percent. On average, 20 percent of unemployed workers receive a voucher (Pfeiffer and Winterhager, 2006), which translates into an increase in the unconditional job finding rate by $2-6$ percent for all unemployed workers. Thus, the available evidence suggests that Hartz III in conjunction with the introduction of the voucher system increased matching efficiency by at least $7-16$ percent.[14] Based on this evidence, we assume

[14]These numbers are likely to under-state the true effect on matching efficiency for two reasons. First, Fahr and Sunde (2009) and Klinger and Rothe (2012) are likely to under-estimate the true effect of Hartz III on matching efficiency since they only consider data until January 2006, and any effect of the Hartz reforms

that restructuring of the Public Employment Agency in conjunction with the adoption of the voucher system for placement services led to an increase in matching efficiency by 7 percent, clearly a conservative choice given the available empirical evidence.

There is additional evidence suggesting that matching efficiency in Germany has been low before the reform and that the potential for substantial efficiency gains was large. First, Kuhn and Jung (2013) find that the cyclical properties of the German job separation and job finding rates can only be explained by the standard matching function approach if matching efficiency in the German labor market is much lower than in the US. Second, substantial gains in matching efficiency are plausible given that in Germany i) job search assistance before the reform was basically non-existent (private providers could not compete because of heavy regulation and the public provider had no incentive to provide good services) and ii) well-executed job search assistance has been shown to have substantial effects on re-employment rates of unemployed job seekers (see Card, Kluve, and Weber, 2010, for a survey). Of course, most of the empirical work on job search assistance is microeconomic in nature and does not take into account the possibility of negative externalities through equilibrium effects (Cahuc and Le Barbanchon, 2010), and a recent study by Crepon et al. (2013) has shown that these effects can be substantial using data for young, educated job seekers in France. However, our calibration is mainly based on the empirical results of Fahr and Sunde (2009) and Klinger and Rothe (2012), who take a semi-aggregate approach that accounts for possible equilibrium effects within an occupation or region. This leaves open the possibility of equilibrium effects across regions or occupations, but these effects are likely to be small in our case given the low levels of regional and occupational mobility in Germany (see Fahr and Sunde, 2009, and Klinger and Rothe, 2012).

As discussed in section 2, the Hartz IV reform consisted of a complete overhaul of the German unemployment insurance system and resulted in a number of far-reaching changes.

---

that materialized after this date is not captured by their estimation. Second, the introduction of vouchers in (2002) injected an element of competition in the market for placement services thereby improving the efficiency of the Public Employment Agency, an effect that is not captured by the empirical work on vouchers or the empirical work on Hartz III.

However, its impact on the net replacement rate of the short-term unemployed, regardless of household type, was limited. It is therefore not surprising that the average net replacement rate for the short-term unemployed was not affected by the reform (figure 3). In contrast, the net replacement rate for the long-term unemployed dropped sharply after the reform for all households without children. For our average measure, we find that the Hartz IV reform reduced the net replacement rate from 0.57 in the period 2000-2004 to 0.46 after the reform in 2005 (see figure 2). Based on this evidence, we follow Krebs and Scheffel (2013) and simulate the effects of Hartz IV assuming that it reduced the net replacement rate for the long-term unemployed from 0.57 to 0.46 and that it left the net replacement rate for the short-term unemployed unchanged.

Labor market reform changes the tax revenues and payouts of the social security system so that after the reform the government budget constraint (4) is in general not satisfied. In other words, both Hartz III and Hartz IV increase employment and therefore production (see below), and the output gains have to be distributed among workers. In our baseline model, we assume that the unemployment insurance tax $\tau$ is reduced after the reform to ensure that (4) holds. For the German labor market reform of 2003-2005 this is a realistic assumption given that before the reform the unemployment insurance system had big financing issues and after the reform the unemployment insurance tax was indeed reduced.

### 6.2 Results

#### 6.2.1 Steady State Effects

We begin with a brief discussion of the long-run effects of the Hartz reforms. To this end, we consider the steady state version of the model and compute the unemployment and welfare effects of an increase in matching efficiency (Hartz III) and a reduction of unemployment benefits for the long-term unemployed (Hartz IV). Table 1 presents the results. Starting from the initial steady state unemployment rate of 10 percent, Hartz III reduces the steady state unemployment rate by 1.58 percentage points and Hartz IV reduces the steady state unemployment rate by 1.29 percentage points. Taken together, the two reforms (Hartz

III plus Hartz IV) reduce the steady state unemployment rate by 2.58 percentage points from 10 percent to 7.42 percent.[15] Thus, our analysis suggests that a significant part of the decrease in the unemployment rate observed in the period 2005-2008 (see figure 1) can be attributed to the Hartz III and Hartz IV reforms and amounts to a reduction in the non-cyclical component of the unemployment rate.

Both Hartz III and Hartz IV reduce steady state unemployment because they increase the steady state values of the job finding rate for the short-term and the long-term unemployed (increase in matching efficiency and more search effort). According to the calibrated model economy, Hartz III and Hartz IV taken together lead to an increase in the job finding rate of the short-term unemployed from 24 percent to 31.7 percent and of the long-term unemployed from 6 percent to 8.9 percent. In the data, the job finding rates of the short-term unemployed increased to about 36 percent and the job finding rate of the long-term unemployed to about 9.3 percent (see Section 2 and figure 3). Thus, we conclude that the time series evidence on job finding rates supports the basic mechanism analyzed in this paper.

Our results regarding the steady state unemployment effects of Hartz IV are in line with the results reported in Krebs and Scheffel (2013), who find that Hartz IV reduced the steady state unemployment rate by 1.4 percentage points. In contrast, Launov and Waelde (2013) report significantly smaller effects, whereas Krause and Uhlig (2012) find that Hartz IV reduced the steady state unemployment rate by 2.8 percentage points. All three studies are based on different models, but Launov and Waelde (2013) provide a detailed analysis of this issue and show that the difference in results is mainly driven by different assumptions about the degree to which Hartz IV affected net replacement rates. Specifically, Launov and Waelde (2013) assume that Hartz IV had on average almost no effect on net replacement rates, Krause and Uhlig (2012) simulate the Hartz IV reform assuming that all low skill workers lost dramatically, and we base our simulation on the average net replacement rate as shown in figure 2.

[15]Note that the total effect of Hartz III and Hartz IV on the unemployment rate is not the sum of the two individual effects because of non-linearities.

Finally, we turn to a welfare comparison. Clearly, an improvement in matching efficiency (Hartz III) increases welfare of all workers regardless of type and also increases social welfare. In contrast, a reduction in unemployment benefits (Hartz IV) has two opposing effects on welfare. On the one hand, there is a negative effect as the reform reduces insurance against unemployment risk. The long-term unemployed are most directly affected by this loss of insurance, but also the short-term unemployed and even the employed take into account that there is a chance that they might become long-term unemployed in the future. On the other hand, the reduction in unemployment benefits increases employment and therefore output. In our baseline model, employed workers gain most directly from the output expansion through the reduction in the social security tax.

Table 1 shows the welfare effects of German labor market reform. For our welfare analysis, we assume that short-term unemployed and long-term unemployed are assigned the same weights $\mu(su) = \mu(lu) = \mu$. Given that we impose the normaliztion $U\mu + (1-U)\mu(e) = 1$ it follows that employed workers have the weight $\mu(e) = \frac{1-U\mu}{1-U}$. Further, the requirement that social welfare weights are non-negative in conjunction with a steady state unemployment rate of 10 percent before the reform imply that $\mu$ varies between 0 (no weight on the unemployed) and 10 (all weight assigned to the unemployed). For simplicity, table 1 show the welfare results for three values of the welfare weights: $\mu = 0, 1, 10$.

As expected, Hartz III increases welfare of all workers and therefore increases social welfare. Further, the increase in social welfare is substantial for all types of social welfare weights (all values of $\mu$). Specifically, Hartz III increases social welfare by 3.13 percent of lifetime consumption if the social planner puts zero weight on the unemployed ($\mu = 0$), it increases social welfare by 3.48 percent of lifetime consumption if equal social welfare weights are used ($\mu = 1$), and it increases social welfare by 6.49 percent of lifetime consumption if the social planner only cares about the unemployed ($\mu = 10$). Hartz IV also increases social welfare substantially independently of the welfare weights, but the welfare gain is only about half of the welfare gain of Hartz III. Overall, Hartz III and IV taken together lead to large increases in social welfare varying between 4.50 percent and 8.50 percent of lifetime

consumption depending on the welfare weights used. Note that in all cases the welfare gains is increasing in $\mu$ – the more weight the social planner puts on the unemployed the larger the welfare gain of labor market reform.

### 6.2.2 Welfare Cost of Business Cycles

We now discuss the welfare costs of business cycles, and how labor market reform affects the welfare costs of business cycles. To this end, we compute the welfare costs of business cycles (15) using different social welfare weights $\mu$ and different values of $\alpha$ – the degree to which the removal of business cycles has an asymmetric effect on job separation rates (see equation (13)). The removal of business cycles has in general an impact on average employment and output. In our baseline model, we adjust the social security tax, $\tau$, so that the government budget constraint (4) remains satisfied after business cycles are eliminated. In our calibrated model economy the elimination of business cycles leads to employment and our gains, which implies that $\tau$ can be reduced. In our robustness analysis we return to this issue and report our results for alternative assumptions about distributing the output gains from eliminating business cycles.

Table 2 shows the welfare cost of business cycles (the gains from stabilization policy) before the Hartz reforms for different ways of removing business cycles (different $\alpha$) and different social welfare weights (different $\mu$). We emphasize two results. First, the welfare costs of business cycles are substantial as long as the elimination of business cycles affects the labor market in an asymmetric way ($\alpha > 0$). For example, the welfare gains from the best type of removing business cycles ($\alpha = 1$), which is equal to the welfare cost of recessions, ranges from 4.84 percent to 7.80 percent of lifetime consumption depending on the welfare weights. Second, the welfare costs of business cycles are increasing in the weight the social planner attaches to the unemployed (increasing in $\mu$). In particular, the welfare cost of business cycles is almost twice as large when the social planner only cares about the unemployed ($\mu = 10$) than when the social planner uses equal weights ($\mu = 1$). The reason is that the elimination of business cycles reduces the average unemployment rate (last column

of table 2), and the welfare gains from this effect is strongest when the social planner cares mainly about the unemployed.

Table 2 also shows that for the welfare costs of business cycles become very small for $\alpha = 0$, the case in which the elimination of business cycles is fully symmetric and has no effect on the mean of the job separation rate: 0.09 percent of lifetime consumption if $\mu = 1$ and 0.19 percent of lifetime consumption if $\mu = 10$. Such small costs of aggregate fluctuations are to be expected given that only probabilities (job separation rates) fluctuate, but not the income realizations (depreciation rates). For one-agent decision problems with expected utility preferences (linearity in probabilities) and constant effort choice, the welfare cost of business cycles are nil (Krebs, 2003). In our setting this result does not exactly hold because of endogenous effort choice and the government budget constraint, which breaks the equivalence between the competitive equilibrium and the social planner problem, but this effect turns out to be small.

Table 3 shows how the Hartz reforms affect the welfare cost of business cycles. We emphasize one main result: labor market reform reduces the welfare cost substantially, with the largest effect if policy makers mainly care about unemployed workers. Specifically, Hartz III reduces the welfare cost of business cycles by almost 15 percent and Hartz IV by 10 percent if the social planner uses a utilitarian welfare function that puts equal weight on all workers. Taken together the two reforms reduce the welfare cost of business cycles by 21 percent for this type of social welfare function. Further, Hartz III reduces the welfare cost of business cycles by about 26 percent and Hartz IV by 17 percent if the social planner uses a utilitarian welfare function that puts all weight on the welfare of unemployed workers, and in this case both reforms taken together reduce the gains from stabilization policy by 38 percent. Interestingly, all these results are independent of the values of $\alpha$ (independent of the way macroeconomic stabilization policy improves social welfare). In other words, Hartz III plus Hartz IV taken together reduce the gains from stabilization policy by about 20 percent if policy makers care about all workers equally and by almost 40 percent if policy makers mainly care about unemployed workers. Moreover, this result is independent of the

way stabilization policy affects the labor market.

Finally, we note that the elimination of business cycles reduces the average unemployment rate, but that this reduction is weaker after the reform. In other words, labor market reform has increased labor market flexibility making the German labor market more resilient to macroeconomic shocks. For example, before the reform the elimination of business cycles with $\alpha = 1$ reduces the unemployment rate by 2.18 percentage points, but after Hartz III and Hartz IV this reduction is only 1.49 percentage points. A glance at equation (17) shows that this effect is an important channel through which Hartz III and Hartz IV reduce the welfare cost of business cycles and hence the gains from stabilization policy. In other words, the hike in the unemployment rate during a typical recession is an important component of the cost of recessions and therefore the cost of business cycles, and the labor market reforms Hartz III and Hartz IV significantly reduced the increase in the unemployment rate during recessions and therefore reduced the welfare cost of business cycles.

To show this unemployment mechanism more clearly, we plot in figure 6 the response of the unemployment rate to an adverse macroeconomic shock before and after the reform. We choose the size and persistence of the increase in the job destruction rate equal to the values that characterize the German labor market during the Great Recession. As shown in Krebs and Scheffel (2013), during the Great Recession the job destruction rate in Germany increased for 8 Quarters by an average of 34 percent relative to trend. Figure 6 shows that in both cases, before and after the reform, the unemployment rate rises for eight quarters in response to the shock, and then declines slowly to its steady state level. However, for the unreformed economy the increase in the unemployment rate peaks at 2.3 percentage points, whereas for the reformed economy the maximum increase is 1.8 percentage points.[16] Further, in the reformed economy the convergence to the steady state is much faster than in the unreformed economy so that the above-trend increase in the unemployment rate

[16]Our analysis suggest that the German unemployment rate should have increased by 1.6 percentage points during the Great Recession, but the actual increase was only 0.8 percentage points. Krebs and Scheffel (2013) show how this discrepancy can be explained through transitional dynamics after the implementation of the Hartz reforms.

during the Great Recession is on average 30 percent smaller in the reformed economy than in the unreformed economy. Thus, we conclude that the Hartz reforms, by increasing labor market flexibility along the job finding margin, have improved the cyclical performance of the German labor market significantly.

### 6.2.3 Robustness Analysis

# References


Acemoglu, D., and R. Shimer (1999) "Efficient Unemployment Insurance," *Journal of Political Economy* 107: 893-928.

Alvarez, F., and U. Jermann (2004) "Using Asset Prices to Measure the Cost of Business Cycles," *Journal of Political Economy* 112: 1223-1256.

Alvarez, F., and N. Stokey (1998) "Dynamic Programming with Homogenous Functions," *Journal of Economic Theory* 82: 167-189.

Addison, J., and Portugal, P (1989), "Job Displacement, Relative Wage Changes, and Duration of Unemployment," *Journal of Labor Economics* 7: 281-302.

Addison, J., Centeno, M., Portugal, P. (2008) "Unemployment Benefits and Reservation Wages: Key Elasticities from a Stripped-Down Job-Search Model," IZA Discussion Paper.

Atkeson, A., and C. Phelan (1994) "Reconsidering the Cost of Business Cycles with Incomplete Markets," *NBER Macroeconomcis Annual*

Auerbach, A., and Y. Gorodnichenko (2012) "Measuring the Output Responses to Fiscal Policy," *AEJ - Economic Policy* 4: 1-27.

Barlevy, G. (2004) "The Cost of Business Cycles under Endogenous Growth," *American Economic Review* 94: 964-990.

Beaudry, P., and C. Pages (2001) "The Cost of Business Cycles and the Stabilization Value of Unemployment Insurance," *European Economic Review* 45: 1545-72.

Blackorby, C., Bossert, W., and D. Donaldson (1999) "Utilitarianism and the Theory of Justice," *Handbook of Social Choice and Welfare*

Blanchard, O., and J. Wolfers (2000) "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence," *Economic Journal* 100: 1-33.

Blundell, R., Costa Dias, M., Meghir, C., and J. van Reenen (2004) "Evaluating te Employment Impact of a Mandatory Job Search Program," *Journal of the European Economic Association* 2: 569-606.

Bohn, H. (1995) "The Sustainibility of Budget Deficits in a Stochastic Economy," *Journal of Money, Credit, and Banking* 27: 257-271.

Bundesagentur fuer Arbeit (2005) "Der Uebergang von der Arbeitslosen- und Sozialhilfe zur Grundsicherung fr Arbeitssuchende," Sonderbericht.

Bundesagentur fuer Arbeit (2011) "Der Arbeitsmarkt in Deutschland: Sockel- und Langzeitarbeitslosigkeit," Arbeitsmarktberichterstattung.

Burda, M. and J. Hunt (2011) "What Explains the German Labor Market Miracle in the Great Recession?" *NBER Macroeconomics Annuals*

Burda, M. and A. Mertens (2001) "Wages and Worker Displacement in Germany," *Labour Economics* 8: 15-41.

Burda, M., and C. Wyplosz (1994) "Gross Worker and Job Flows in Europe," *European Economic Review* 38: 1287-315.

Cahuc, P., and T. Le Barbanchon (2010) "Labor Market Policy Evaluation in Equilibrium: Some Lessons of the Job Search and Matching Model," *Labour Economics* 17: 196-205.

Card, D., Kluve, J. and A. Weber (2010) "Active Labour Market Policy Evaluation: A Meta-Analysis," *Economic Journal* 120: 452-477.

Card, D., Chetty, R., and A. Weber (2007) "Cash-On-Hand and Competing Models of Intertemporal Behavior: New Evidence from the Labor Market," *Quarterly Journal of Economics* 122: 1511-1560.

Chetty, R. (2008) "Moral Hazard vs Liquidity and Optimal Unemployment Insurance," *Journal of Political Economy* 116: 173-234.

Christoffel, K., Kuester, K., and T. Linzert (2009) "The Role of Labor Market Policy for Euro Area Monetary Policy," *European Economic Review* 53: 908-936.

Crepon, B., Duflo, E., Gurgand, M., Rathelot, R. and P. Zamora (2013) "Do labor Market Policies Have Displacement Effects: Evidence from a Clustered Randomized Experiment," *Quarterly Journal of Economics* 128: 531-580.

Dao, M., and P. Loungani (2010) "The Human Cost of Recessions: Assessing It, Reducing It," *IMF Staff Position Notes SPN/10/17*

Davis, S. and T. Wachter (2011) "Recessions and the Cost of Job Loss," *Brookings Papers on Economic Activity*

Den Haan, W., Ramey, G., and J. Watson (2000) "Job Destruction and Propagation of Shocks," *American Economic Review* 90: 482-498.

Den Haan, W., and P. Sedlack (2013) "Inefficient Continuation Decisions, Job Creation Costs, and the Cost of Business Cycles," *Working Paper*

Fahr, R., and U. Sunde (2009) "Did the Hartz Reforms Speed Up the Matching Process? A Macro-Evaluation Using Empirical Matching Functions," *German Economic Review* 10, 284-316.

Gali, J., Gertler, M., and J. Lopez-Salido (2007) "Markups, Gaps, and the Welfare Costs of Business Fluctuations," *Review of Economics and Statistics* 89: 44-59.

Hairault, J., Lagot, F., and S. Osotimehim (2010) "Matching Frictions, Unemployment Dynamics, and the Cost of Business Cycles," *Review of Economic Dynamics* 13; 759-779.

Hall, R. (1995) "Lost Jobs," *Brookings Papers on Economic Activity* 1: 221-56.

Hartz, P., N. Bensel, J. Fiedler, H. Fischer, P. Gasse, W. Jann, P. Kraljic, I. Kunkel-Weber, K. Luft, H. Schartau, W. Schickler, H.-E. Schleyer, G. Schmid, W. Tiefensee, and E. Voscherau (2002) "Moderne Dienstleistungen am Arbeitsmarkt, *Bericht der Kommission*.

Hofmann, B. (2012) "Short- and Long-Term ex Post Effects of Unemployment Insurance Sanctions," *Journal of Economics and Statistics* 232: 31-60.

Hertweck, M., and O. Sigrist (2012) "The Aggregate Effects of the Hartz Reforms in Germany," Working Paper

Hunt, J. (1995) "The Effect of Unemployment Compensation on Unemployment Duration in Germany," *Journal of Labor Economics* 13: 88-120.

Hansen, G., and A. Imrohoroglu (1992) "The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard," *Journal of Political Economy* 100: 118-142.

IMF World Economic Outlook (2012) "Coping with High Debt and Sluggish Growth".

Jacobi, L., and J. Kluve (2006) "Before and After the Hartz Reforms: The Performance of Active Labor Market Policy in Germany," IZA Discussion Paper.

Jung, P., and K. Kuester (2011) "The (Un)Importance of Unemployment Fluctuations for Welfare," *Journal of Economic Dynamics and Control* 35: 1744-1768.

Jung, P., and K. Kuester (2013) "Optimal Labor Market Policy in Recessions," *American Economic Journal: Macroeconomics* forthcoming.

Jung, P., and M. Kuhn (2013) "Labor Market Institutions and Worker Flows: Comparing Germany and the US?", *Economic Journal* forthcoming.

Keane, M., and K. Wolpin "The Career Decision of Young Men," *Journal of Political*

*Economy* 105: 473-522.

Krause, M., and H. Uhlig (2012) "Transitions in the German Labor Market: Structure and Crisis," *Journal of Monetary Economics* 59: 64-79.

Krebs, T. (2003) "Growth and Welfare Effects of Business Cycles with Economies with Idiosyncratic Human Capital Risk," *Review of Economic Dynamics* 6: 846-68.

Krebs, T. (2007) "Job Displacement Risk and the Cost of Business Cycles," *American Economic Review* 97: 664-686.

Krebs, T., and M. Scheffel (2013) "Macroeconomic Evaluation of Labor Market Reform in Germany," *IMF Economic Review*.

Krusell, P., and A. Smith (1999) "On the Welfare Effects of Eliminating Business Cycles," *Review of Economic Dynamics* 2: 245-272.

Krusell, P., Mukoyama, T., Sahin, A., and A. Smith (2009) "Revisiting the Welfare Effects of Eliminating Business Cycles," *Review of Economic Dynamics*

Lalive, R., Landais, C., and J. Zweimueller (2013) "Market Externalities of Large Unemployment Insurance Extension Programs," *Working Paper*

Landais, C., Michaillat, P., and E. Saez (2010) "Optimal Unemployment Insurance over the Business Cycle," NBER Working Paper

Launov, A., and K. Waelde (2013a) "Estimating Incentive and Welfare Effect of Nonstationary Unemployment Benefits," *International Economic Review* 54: 1159-1198.

Launov, A., and K. Waelde (2013b) "Thumbscrews for Agencies or for Individuals? How to Reduce Unemployment," *Working Paper*.

Lucas, R. (1987) *Models of Business Cycles*. London: Blackwell Publishing.

Lucas, R. (2003) "Macroeconomic Priorities," *American Economic Review* 93: 1-14.

Ljungqvist, L., and T. Sargent (1998) "The European Unemployment Dilemma," *Journal of Political Economy* 514-550.

Meyer, B. (1990) "Unemployment Insurance and Unemployment Spells," *Econometrica* 58: 757-782.

Meyer, B., and A. Krueger (2002) "Labor Supply Effects of Social Insurance," *Handbook of Public Economcis*

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

Mueller, K., and V. Steiner (2008) "Imposed Benefit Sanctions and the Unemployment-to-Employment Transition: The German Experience," *DIW Discussion Paper 792*.

Neal, D. (1995) "Industry-Specific Human Capital: Evidence from Displaced Workers," *Journal of Labor Economics*

Petrongolo, B., and C. Pissarides (2001) "Looking into the Balck Box: A Survey of the Matching Function *Journal of Economic Literature* 39: 390-431.

Pissarides, C. (1992) "Loss of Skill During Unemployment," *Quarterly Journal of Economics* 107: 1371-1391.

Pfeiffer, F., and H. Winterhager (2006) "Vermittlungsgutscheine und Beauftragung Dritter im Vergleich," *Zeitschrift fuer Arbeitsmarktforschung* 39: 425-445.

Schmieder, J., Wachter, T., and S. Bender (2012) "The Effects of Extended Unemployment Insurance over the Business Cycle: Evidence from Regression Discontinuity Estimation over Twenty Years," *Quarterly Journal of Economics* 127: 701-752.

Schmieder, J., Wachter, T., and S. Bender (2013) "The Causal Effect of Unemployment Duration on Wages: Evidence from Unemployment Insurance Extension," Working Paper.

Storesletten, K., Telmer, C., and A. Yaron (2001) "The Welfare Cost of Business Cycles Revisited: Finite Lifes and Cyclical Variations in Idiosyncratic Risk," *European Economic Review* 45: 1311-39.

Tallarini, T. (2000) "Risk-Sensitive Real Business Cycles," *Journal of Monetary Economics* 45: 507-532.

Winterhager, H., Heinze, A., and A. Spermann (2006) "Deregulating Job Placement in Europe: A Microeconometric Evaluation of an Innovative Voucher System in Germany," *Labour Economics* 13: 505-517.

Yellen, J. (2013) "Monetary Policy: Many Targets, Many Instruments. Where Do We Stand?" Speech given at the IMF Confererence "Rethinking Macro Policy II" on April 16, 2013.

Yellen, J., and G. Akerlof (2006) "Stabilization Policy: A Reconsideration," *Economic Inquiry* 44: 1-22.

Table 1. Steady State Effects of German Labor Market Reform

| | $\Delta U$ | $\Delta W_0$ | $\Delta W_1$ | $\Delta W_2$ |
|---|---|---|---|---|
| Hartz III | -1.58% | 3.13% | 3.48% | 6.49% |
| Hartz IV | -1.29% | 1.58% | 1.75% | 3.28% |
| Hartz III + Hartz IV | -2.58% | 4.50% | 4.93% | 8.49% |

Note: $\Delta U$ is the change in the unemployment rate in percentage points. $\Delta W0$ is the welfare effect of labor market reform if the social planner puts zero weight on the unemployed ($\mu = 0$), $\Delta W1$ is the welfare effect if the social planner uses equal welfare weights ($\mu = 1$), and $\Delta W2$ is the welfare effect if the social planner only cares about unemployed workers ($\mu = 10$). Welfare effects are measured in percent of lifetime consumption.

Table 2. Welfare Cost of Business Cycles

| | $\Delta_0$ | $\Delta_1$ | $\Delta_2$ | $\Delta U$ |
|---|---|---|---|---|
| $\alpha = 0$ | 0.077% | 0.089% | 0.195% | −0.058% |
| $\alpha = 0.33$ | 1.71% | 1.86% | 3.13% | −0.83% |
| $\alpha = 0.66$ | 3.28% | 3.53% | 5.62% | −1.53% |
| $\alpha = 1$ | 4.84% | 5.16% | 7.79% | −2.18% |

Note: $\Delta_0$ is the welfare cost of business cycles (percentage of lifetime consumption) if the social planner puts zero weight on the unemployed ($\mu = 0$), $\Delta_1$ if the social planner uses equal weights ($\mu = 1$), and $\Delta_2$ if the social planner only cares about unemployed workers ($\mu = 10$). $\alpha$ measures the degree of asymmetry (the effectiveness) of stabilization policy. $\Delta U$ is the change in the unemployment rate in percentage points.

Table 3. German Labor Market Reform and Welfare Cost of Business Cycles

| | $\Delta_0$ | $\Delta\Delta_0$ | $\Delta_1$ | $\Delta\Delta_1$ | $\Delta_2$ | $\Delta\Delta_2$ |
|---|---|---|---|---|---|---|
| Hartz III | | | | | | |
| $\alpha = 0.33$ | 1.51% | −11.8% | 1.59% | −14.2% | 2.32% | −25.9% |
| $\alpha = 0.66$ | 2.89% | −12.0% | 3.02% | −14.4% | 4.17% | −25.2% |
| $\alpha = 1$ | 4.25% | −12.1% | 4.42 % | −14.3% | 5.78% | −25.8% |
| Hartz IV | | | | | | |
| $\alpha = 0.33$ | 1.57% | −8.12% | 1.68% | −9.78% | 2.59% | −17.4% |
| $\alpha = 0.66$ | 3.01% | −8.2% | 3.19% | −9.7% | 4.66% | −17.2% |
| $\alpha = 1$ | 4.45% | −8.1% | 4.68 % | −9.5% | 6.48% | −16.8% |
| Hartz III+IV | | | | | | |
| $\alpha = 0.33$ | 1.40% | −18.1% | 1.50% | −21.4% | 1.96% | −37.5% |
| $\alpha = 0.66$ | 2.68% | −18.3% | 2.77% | −21.5% | 3.51% | −37.5% |
| $\alpha = 1$ | 3.94% | −18.4% | 4.06 % | −21.4% | 4.89% | −37.2% |

Note: $\Delta_0$ is the welfare cost of business cycles if the social planner puts no weight on the unemployed, $\Delta_1$ is the welfare cost of business cycles if equal welfare weights are used, and $\Delta_2$ if the social planner only cares about unemployed workers (measured in percent of lifetime consumption). $\Delta\Delta_1$ and $\Delta\Delta_2$ are the percentage changes of the welfare cost of business cycles due to reform. $\alpha$ measures the degree of asymmetry of stabilization policy.

# Appendix

## Appendix A: German Labor Market Reform 2003-2005

### A1. The Reform

We begin with a description of the main elements of the Hartz reforms. Jacobi and Kluve (2007) provide a detailed account of the Hartz reforms and Wunsch (2005) provides a comprehensive survey of German labor market policy before the reform.

In 2002 the German government enacted the so-called JOB-AQTIV amendment and then implemented in 2003-2005 a number of far-reaching labor market reforms, the so-called Hartz reforms.[17] The Hartz reforms consisted of four laws that were implemented in three steps in January 2003 (Hartz I+II), January 2004 (Hartz III), and January 2005 (Hartz IV). Their core elements were based on recommendations made by an expert commission (Hartz et al. 2002) that was headed by Peter Hartz, the Chief Human Resources Officer of Volkswagen at that time. Our description focuses on the last two parts of teh reform, Hartz III and Hartz IV.

The main purpose of Hartz III was to improve job placement services for unemployed job seekers. To this end, Hartz III entailed a complete restructuring of the Public Employment Agency. Specifically, the Agency was transformed from a strongly centralized and bureaucratic institution with little quality control into a decentralized, customer-oriented organization with a high degree of responsibility and accountability of local employment offices (called job centers after the reform). Further, in the wake of the reform many services were streamlined and heavy emphasis was placed on job search assistance to improve the process of matching unemployed workers with vacant jobs. In addition, the reform broke the de facto monopoly of the Public Employment Agency, which introduced competition in the

[17]Until 1997 the legal basis of German labour market policy was the Employment Promotion Act (Arbeitsfoerderungsgesetz). In addition to passive income support for the unemployed it strongly emphasized the need for public training and job creation programs for both the employed and unemployed. In 1998 the Employment Protection Act was replaced by the Social Code III (Sozialgesetzbuch III), which shifted the attention away from public sector training and job creation programs towards helping the unemployed job seeker to find private-sector employment as quickly as possible. In this sense the enactment of the Social Code III in 1998 foreshadowed the paradigm shift in German labor market policy that took place in the period 2003-2005.

market for job placement services. In particular, a voucher system was introduced providing individual job seekers with the opportunity to choose private placement agencies.[18]

The main objective of Hartz IV was to activate unemployed job seekers. To this end, Hartz IV entailed a complete overhaul of the German unemployment insurance and welfare system. Before the reform, this system was characterized by a very long period of Unemployment Benefit entitlement followed by a relatively generous and essentially unlimited, means-tested Social Welfare Program (consisting of a combination of Unemployment Assistance and/or Social Assistance). Further, very little effort was made to re-integrate the long-term unemployed and/or welfare recipients into the formal labor market. The Hartz IV reform reduced the benefits payments for many of the long-term unemployed/welfare recipients and introduced new measures to activate the long-term unemployed/welfare recipients.[19] The Hartz IV reform resulted in a simple two-tier unemployment insurance system in which most unemployed workers with unemployment spells less than one year (short-term unemployed) receive unemployment benefits that are proportional to earnings at the last job (called Unemployment Benefit I) and most unemployed workers with an unemployment spell of more than one year (long-term unemployed) receive means-tested payments that heavily depend on household composition (called Unemployment Benefit II).

The Hartz IV reform reduced unemployment payments for many households, but the extent of the reduction varies substantially across household groups and length of unemployment spell. One way to aggregate this heterogeneity is to follow the OECD and to report the median net replacement rate for short-term unemployed households, defined as unemploy-

[18]The voucher system was already introduced in 2002 as part of the Job-AQTIV amendment, but Hartz III and Hartz IV subsequently allowed for a more wide-spread application of vouchers. The Job-AQTIV amendment in 2002 and Hartz I in 2003 also introduced the possibility that the Public Employment Agency outsources placement services to private providers (temporary work agencies).

[19]The first step made in the direction of improved monitoring of job search was taken with the Job-AQTIV amendment in 2002. This amendment introduced qualitative profiling of job-seekers upon unemployment registration with the Local Employment Agency (LEA) and a compulsory written agreement between the LEA and the job-seeker (Eingliederungsvereinbarung) in order to determine the duties and efforts of both contracting parties during the job-search process. Hartz I then tightened in 2003 the conditions for the acceptability of jobs and introduced benefit sanctions in the case of non-compliance. The eligibility period for short-term unemployment benefits (Unemployment Benefit I) was reduced in February 2006, but this change was not officially a part of the Hartz-laws and had only a small effect on the average net replacement rate.

ment spell less than one year, and long-term unemployed households. Figure 5 shows the net replacement rate for single households with median labor income before the unemployment spell based on the OECD data (see the Appendix for more details on the construction of this variable). Clearly, Hartz IV, which was enacted in January 2005, had almost no effect on the net replacement rate of the short-term unemployed, but a very large effect on the net replacement rate of the long-term unemployed. For this measure, we find that the Hartz IV reform reduced the net replacement rate from 0.57 in the period 2000-2004 to 0.46 after the reform in 2005. Based on this evidence, we simulate the effect of Hartz IV in section 6 assuming that it reduced the net replacement rate for the long-term unemployed from 0.57 to 0.46 and that it left the net replacement rate for the short-term unemployed unchanged.

Finally, the main objectives of Hartz I and Hartz II, implemented in January 2003, were to reduce labor costs through wage subsidies, to create new employment opportunities, and to redesign and streamline existing training programs and (public) job creation schemes. For example, these laws eliminated the social security tax for jobs paying up to 400 Euro per month (Mini-job) and reduced social security contributions for jobs paying up to 800 Euro per month (Midi-jobs) and for firms hiring older workers. Further, various forms of subsidies are paid to employers when hiring certain types of hard-to-place workers and to unemployed workers who decide to become self-employed. They also deregulated the labor market by weakening restrictions on temporary work agencies and fixed-term contracts.[20]

### A2. Empirical Evidence on Hartz III and Hartz IV

The best known empirical studies about the effects of Hartz III on matching efficiency are Fahr and Sunde (2009) and Klinger and Rothe (2012), who use labor market flow data to estimate matching functions for the German labor market before and after the Hartz III reform. Fahr and Sunde (2009) find that Hartz III increased the efficiency parameter of the estimated matching function by 11.6 percent for manufacturing occupations and around 5 percent for non-manufacturing occupations according to their most preferred specification (column 4 of table 5). Klinger and Rothe (2012), who do not distinguish between manu-

[20]The law abolished restrictions on re-employment, synchronization, fixed-term contracts, and the maximum duration of temporary work. However, the law also requires temporary work agencies to either guarantee equal pay and equal treatment of temporary workers and regular workers or to join a collective bargaining agreement.

facturing and non-manufacturing, find an increase in matching efficiency around 5 percent (see their table 2). Hertwick and Sigrist (2012) provide evidence that the German Beverage curve shifted inwards around the mid 2000s and estimate that the Hartz reforms taken together (Hartz I-IV) increased matching efficiency by 20 percent. Finally, Launov and Wealde (2013) use a calibrated search and matching model of the German labor market to argue that the estimated efficiency gains due to Hartz III have reduced steady state unemployment by almost 2 percentage points.

Empirical work using micro data support the view that the introduction of vouchers for job placement services had positive effects on matching efficiency. Winterhager, Heinze, and Spermann (2006) use a very rich administrative data set provided by the Federal Employment Agency to analyze the efficiency improvements generated by the market-based approach to job placement introduced with the Hartz reforms. Specifically, they apply propensity score matching to estimate the effect of the job placement voucher scheme comparing voucher recipients to a matched control group of non-recipients. They define treatment in the evaluation design as receipt of a first voucher during the unemployment spell in May and June 2003, and outcome as employment within 12 months after voucher issue. The main finding of Winterhager, Heinze, and Spermann (2006) is that 12 months after the receipt of a voucher, 27.09 percent of the recipients are in regular employment, whereas only 20.60 percent of the matched control group are employed. Thus, the average treatment effect on the treated amounts to an increase in the job finding rate by around 30 percent - a very large effect indeed. Their results are in line with the finding of Pfeiffer and Winterhager (2006), who find strong evidence for positive effects of vouchers for job placement services on re-employment probabilities.

There is no micro-econometric work evaluating the effect of the benefit reductions associated with Hartz IV on job-finding rates of the unemployed, mainly because the Hartz IV reform entailed a significant change in the official measurement of unemployment.[21] However, the available evidence based on structural models of the German labor market (Krause and Uhlig, 2012, Krebs and Scheffel, 2013) suggests substantial effects of Hartz IV on job

[21]This added more than half a million workers to the pool of unemployed between January 2005 and March 2005 (see Bundesagentur fuer Arbeit, 2005) and explains the spike in the unemployment rate in 2005. more than 80 percent of these added unemployed workers lacked the equivalent of a high school degree.

finding rates and equilibrium unemployment. Further, empirical work estimating the effect of changes in unemployment generosity on re-employment probabilities for Germany using data before the Hartz IV reform suggests substantial effects (Hunt, 1995), in line with the findings for the US (Krueger and Meyer, 2002). We review the literature in more detail in Section 5 on calibration.

## Appendix B: Proof of Proposition 1

To ease the notation, we confine attention to the case of a constant interest rate $r_{f,t} = r_f$ and job finding rates that are independent of the state of the labor market. Consider an extended household maximization problem with endogenous choice of human capital. Specifically, suppose that the household can transform one unit of the good into $\nu(s)$ units of human capital and denote the (resource) cost of human capital investment by $x$. Thus, the extended household maximization problem is the problem of choosing $\{c_t, a_t, h_t, x_t, l_t\}$ so as to maximize (2) subject to the sequential budget constraint

$$a_{t+1} = \begin{cases} (1+r_f)a_t + \phi(s_t) - c_t - x_t & if\ a_{t+1} \geq 0 \\ (1+r_f+\varphi)a_t + \phi(s_t) - c_t - x_t & if\ a_{t+1} < 0 \end{cases}$$

$$h_{t+1} = (1+\epsilon(s_t, s_{t+1}))\,(h_t + \nu_t x_t) \qquad (A1)$$

where $\epsilon$ and $\phi$ are the same functions as in the basic household decision problem of maximizing (2) subject to (1).

Clearly, if $\{c_t^*, a_t^*, h_t^*, x_t^*, l_t^*\}$ solves the extended household maximization problem with $x_t^* = 0$, then $\{c_t^*, a_t^*, l_t^*\}$ solves the basic household decision problem for given $\bar{h}_t = h_t^*$. In particular, if $\{c_t^*, a_t^*, h_t^*, x_t^*, l_t^*\}$ solves the extended household maximization problem with $x_t^* = 0$ and $a_t^* = 0$, then $\{c_t^*, a_t^*, l_t^*\}$ with $a_t^* = 0$ solves the basic household decision problem for given $\bar{h}_t = h_t^*$. Thus, proposition 1 is proved if we can construct a solution $\{c_t^*, a_t^*, h_t^*, x_t^*, l_t^*\}$ to the extended household maximization problem with $x_t^* = 0$ and $a_t^* = 0$. We now show how to construct such a plan if the interest rate, $r_f$, is given by (6) and the financial intermediation cost is not less than $\varphi_{min}$ defined in (7).

Define the following new variables:

$$\tilde{c}_t = \nu_t\, c_t$$

$$
\begin{aligned}
w_{t+1} &= (1+r_{t+1})\left(h_{t+1}/(1+\epsilon_{t+1})+\nu_t a_{t+1}\right) \\
\theta_{a,t+1} &= \frac{\nu_t\,(1+r_{t+1})a_{t+1}}{w_{t+1}} \\
\theta_{h,t+1} &= \frac{(1+r_{t+1})h_{t+1}}{(1+\epsilon_{t+1})w_{t+1}} \\
1+r_{t+1} &= \begin{cases} \theta_{a,t+1}\left(\frac{\nu_{t+1}}{\nu_t}(1+r_f)\right)+\theta_{h,t+1}(1+\epsilon_{t+1})(1+\phi_{t+1}\nu_{t+1}) & if\ \theta_{at}\geq 0 \\ \left(\frac{\nu_{t+1}}{\nu_t}(1+r_f+\varphi)\right)+\theta_{h,t+1}(1+\epsilon_{t+1})(1+\phi_{t+1}\nu_{t+1}) & if\ \theta_{at}<0 \end{cases}
\end{aligned}
$$

Here $w$ is the value of total wealth, financial and human, including asset payoffs in period $t+1$, $\theta$ is the share of total wealth invested in financial assets, and $r$ is the total return on investment (in human and physical capital). Note that $h_{t+1}/(1+\epsilon_{t+1})+\nu_t a_{t+1}$ is total wealth excluding asset payoffs in period $t+1$. Using the new definitions, the household budget constraint (A1) can be written as

$$
\begin{aligned}
w_{t+1} &= (1+r(\theta_{a,t+1},\theta_{h,t+1}s_t,s_{t+1}))\,(w_t-c_t) \\
&\theta_{a,t+1}+\theta_{h,t+1} = 1 \qquad\qquad (A2) \\
&w_{t+1}\geq 0\ ,\ \ \theta_{h,t+1}\geq 0
\end{aligned}
$$

The extended household maximization problem is to choose a plan $\{c_t, w_t, \theta_{at}, \theta_{ht}, l_t\}$ that maximizes (1) subject to (A2).

The Bellman equation associated with the extended household maximization problem reads

$$
\begin{aligned}
V(w,s) &= \max_{c,\theta'_a,\theta'_h,w',l}\left\{ln\,\tilde{c}-\ln\nu(s)-d(l,s)+\beta\sum_{s'}V(w',s')\pi(s'|s,l)\right\} \\
&s.\,t.\ \ w' = (1+r(\theta'_a,\theta'_h,s,s'))(w-c) \\
&\theta'_a+\theta'_h = 1 \qquad\qquad (A3) \\
&w'\geq 0\ ,\ \ \theta'_h\geq 0
\end{aligned}
$$

where the effort choice, $l$, is only relevant if $s=su,lu$. The extended household maximization problem has the feature that probabilities depend on choices, in contrast to the class of problems analyzed in Stokey and Lucas (1989). However, the standard argument for the principle of optimality still applies, and without loss of generality we can confine attention to solving (A3) subject to a corresponding transversality condition.

There is a technical issue regarding the construction of the appropriate function space since the economic problem is naturally an unbounded problem. To deal with this issue, one can, for example, follow Streufert (1990) and consider the set of continuous functions $B_W$ that are bounded in the weighted sup-norm $||V|| \doteq sup_x|V(x)|/W(x)$, where $x = (w, \theta, s)$ and the weighting function $W$ is given by $W(x) = |L(x)| + |U(x)|$ with $U$ an upper bound and $L$ a lower bound, and endow this function space with the corresponding metric. Thus, $B_W$ is the set of all functions, $V$, with $L(x) \leq V(x) \leq U(x)$ for all $x \in \mathbf{X}$. A straightforward but tedious argument shows that confining attention to this function space is without loss of generality. More precisely, one can show that there exist functions $L$ and $H$ so that for all candidate solutions, $V$, we have $L(x) \leq V(x) \leq H(x)$ for all $x \in \mathbf{X}$.[22]

The Bellman equation (A3) has a simple solution. More precisely, the optimal portfolio choice, $(\theta'_a, \theta'_h)$, is independent of wealth, $w$, and consumption and next-period wealth are linear functions of current wealth:

$$\begin{aligned} c &= (1-\beta)w \qquad (A4) \\ w' &= \beta(1 + r(\theta', s, s'))w \ . \end{aligned}$$

Moreover, the value function has the functional form

$$V(w, s) = \tilde{V}(s) + \frac{1}{1-\beta} \ln w \qquad (A5)$$

and the optimal portfolio choice and optimal search effort are the solution to the intensive-form Bellman equation

$$\tilde{V}(s) = \max_{\theta'_a, \theta'_h, l} \left\{ B - \nu(s) - d(l, s) + \frac{\beta}{1-\beta} \sum_{s'} ln\,(1 + r(\theta'_a, \theta'_h, s, s'))\pi(s'|s, l) + \beta \sum_{s'} \tilde{V}(s')\pi(s'|s, l) \right\} ,$$

$$\theta'_a + \theta'_h = 1 \ , \ \theta'_h \geq 0 \qquad (A6)$$

where $B$ is a constant. It is straightforward to show that this solution satisfies the relevant transversality condition.

---

[22] Alvarez and Stokey (1998) provide a different, but related argument to prove the existence and uniqueness of a Bellman equation for a class of unbounded problems similar to the one considered here (without moral hazard).

Clearly, the maximization problem (A6) is a convex problem (concave objective function and convex choice set), and first-order conditions are therefore necessary and sufficient. These first-order condition read

$$0 \;\leq\; \sum_{s'} \frac{(1+\epsilon(s,s'))(1+\phi(s')\nu(s')) \;-\; \frac{\nu(s')}{\nu(s)}(1+r_f)}{1+r(\theta'_a,\theta'_h,s,s')}\,\pi(s'|s,l) \quad if\ \theta'_a \geq 0 \qquad (A7)$$

$$0 \;\geq\; \sum_{s'} \frac{(1+\epsilon(s,s'))(1+\phi(s')\nu(s')) \;-\; \frac{\nu(s')}{\nu(s)}(1+r_f+\varphi)}{1+r(\theta'_a,\theta'_h,s,s')}\,\pi(s'|s,l) \quad if\ \theta'_a \leq 0$$

where the first inequality has to hold with equality if $\theta'_a > 0$ and the second inequality has to hold with equality if $\theta'_a < 0$. Note that the numerator is the excess return of human capital investment over the return to financial investment and that $(1+r)^{-1}$ is the marginal utility of consumption. Thus, equation (A7) says that expected marginal utility weighted returns are equalized across assets, a well-known optimality condition in portfolio choice theory.

Suppose the human capital productivity parameter $\nu$ is chosen as

$$\nu(s) \;=\; \frac{1-\beta}{\beta}\frac{1}{\phi(s)} \qquad (A8)$$

Using this condition and substituting $\theta'_a = 0$ and $\theta'_h = 1$ into (A7) yields:

$$1 \;\geq\; \beta\sum_{s'} \frac{\phi(s)}{\phi(s')}\frac{1+r_f}{1+\epsilon(s,s')}\,\pi(s'|s,l) \qquad (A9)$$

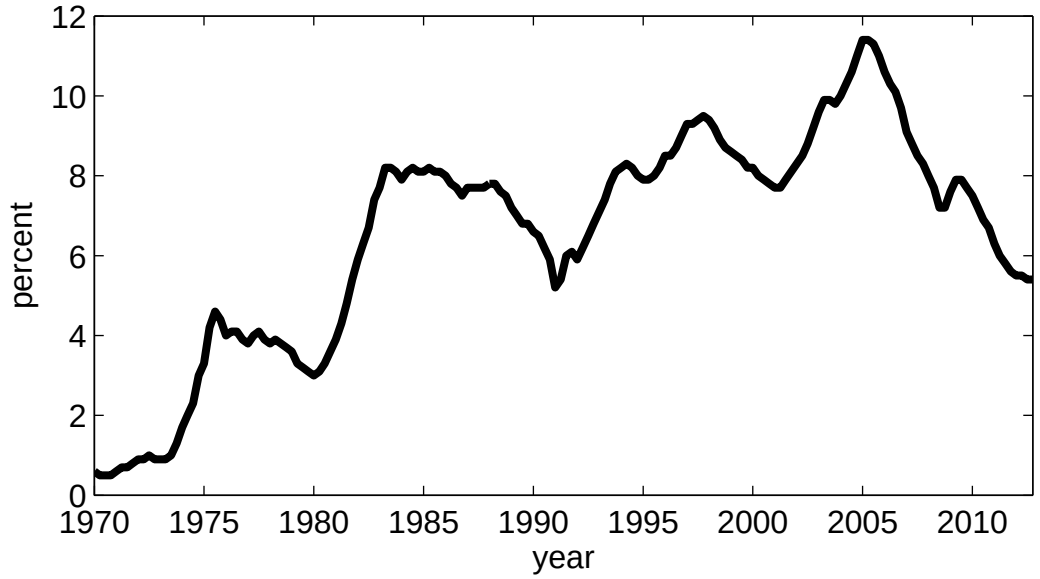
$$1 \;\leq\; \beta\sum_{s'} \frac{\phi(s)}{\phi(s')}\frac{1+r_f+\varphi}{1+\epsilon(s,s')}\,\pi(s'|s,l)$$

Clearly, if the interest rate, $r_f$, is set according to (6) and the financial intermediation cost is at least as large as $\varphi_{min}$ given in (7), then (A9) is satisfied (and holds with equality if the cost is equal to $\varphi_{min}$). Straightforward algebra shows that in this case the value function (A5) reduces to (8) and equation (A6) becomes (9). Further, in this case the optimal plan given by (A4) is simply $c_t = \phi(s_t)h_t$ and $h_{t+1} = (1+\epsilon(s_t,s_{t+1}))h_t$. This completes the proof of proposition 1.

## Appendix C: Proof of Propsition 2

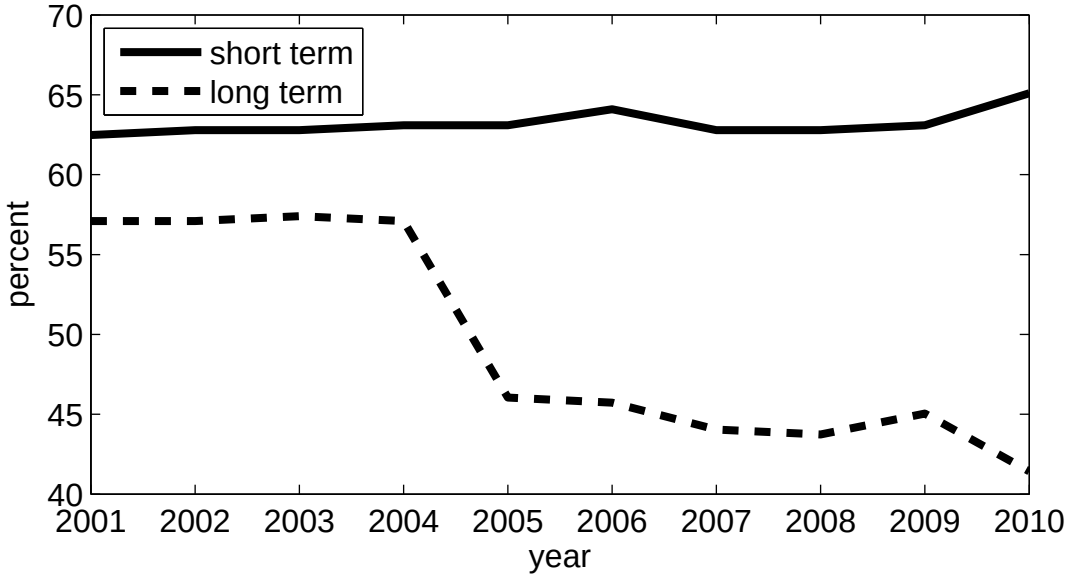
To be written

**Figure 1:** Quarterly Unemployment Rate, Germany 1970Q1-2012Q4



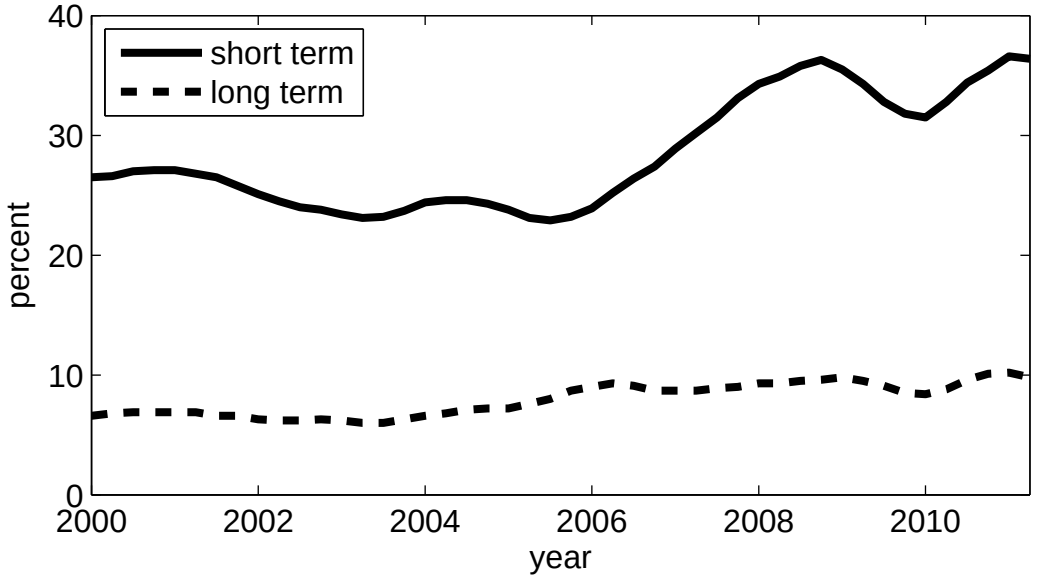

*Source: OECD: 1970-1990, quarterly unemployment rate for West Germany; 1991-2012, quarterly harmonized unemployment rate for Germany.*

**Figure 2:** Average Net Replacement Rate, Germany 2001-2010



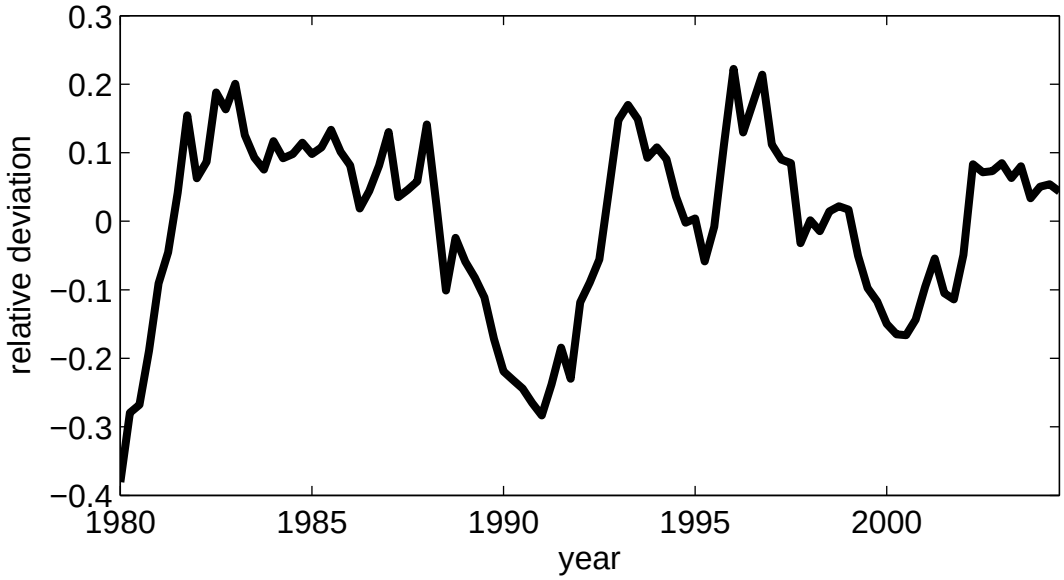

*Source: OECD: (1) net replacement rates: OECD Tax-Benefit Modes, (2) population weights: OECD Family Database.*

**Figure 3:** Quarterly Job Finding Rates by Unemployment Duration, Germany 2000Q1-2011Q2



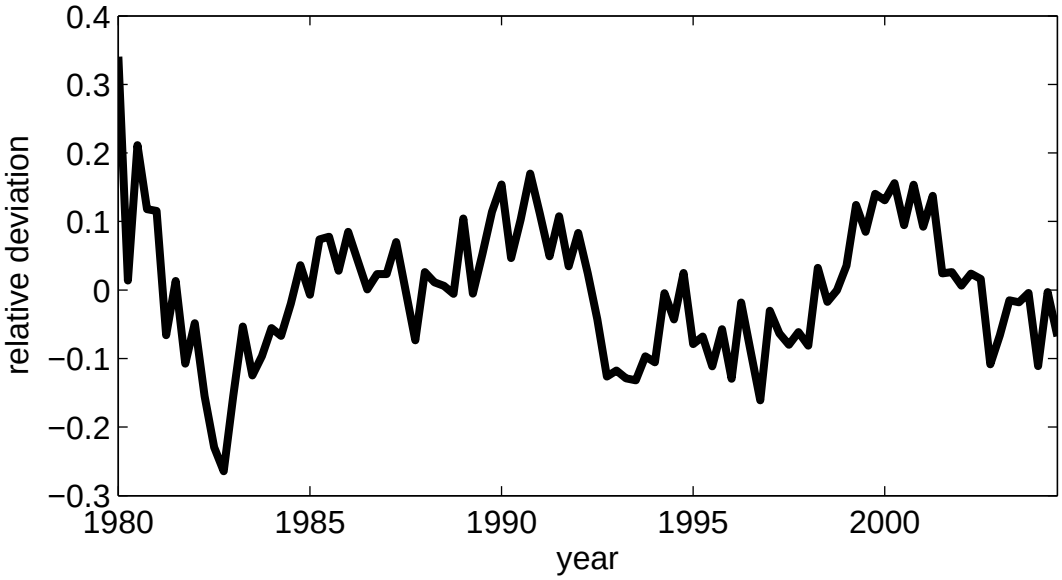

*Source: Bundesagentur für Arbeit (2011).*

**Figure 4:** Deviation of Job Separation Rate from Trend, Germany 1980Q1-2004Q4




*Source: Jung and Kuhn (2013).*

**Figure 5:** Deviation of Job Finding Rate from Trend, Germany 1980Q1-2004Q4




*Source: Jung and Kuhn (2013).*

**Figure 6:** Unemployment Response to Job Separation Shock, Hartz III-IV