Hartz IV and the Decline of German Unemployment: A Macroeconomic Evaluation

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Abstract

This paper proposes a new approach to evaluate the macroeconomic effects of the Hartz IV reform in Germany, which reduced the generosity of long-term unemployment benefits. We use a model, where the reform initiates both a partial and an equilibrium effect. We are the first to use the IAB Job Vacancy Survey to quantify these effects. Our indirect inference method provides a solution for the existing disagreement in the macroeconomic literature on Hartz IV. We find that unemployment dropped by 3.1 percentage points due to Hartz IV.

JEL classification: E24, E00, E60

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1 Introduction

Unemployment in Germany declined from 12 percent in 2005 to 6 percent in 2017. At the beginning of this steep decline in 2005, Germany implemented a major reform of its unemployment benefit system. Before the reform, long-term unemployed received benefits proportional to their prior net earnings. These proportional benefits were abolished in 2005 and replaced by a means-tested transfer (dubbed as „Hartz IV“) that is independent of prior employment history and should only assure a minimum subsistence level. There is still no consensus on how much the restructuring of the long-term unemployment benefit system contributed to the subsequent decline in unemployment. The results from macroeconomic evaluations differ substantially. Krause and Uhlig (2012) and Krebs and Scheffel (2013) argue that unemployment has declined by 2.8 and 1.4 percentage points due to Hartz IV, respectively. By contrast, Launov and Wälde (2013) argue that the decline of unemployment due to Hartz IV was just 0.1 percentage points. These macroeconomic studies use counterfactual model simulations to quantify the effects of the reform, which require assumptions on the reform-induced change of the replacement rate. As the reform affected claimants differently depending on e.g. their prior benefit level or family status, there is no agreement on how to quantify the actual fall of the replacement rate (see Section 2 for details). The estimates of the latter range from 7% for the average long-term unemployed (see Launov and Wälde, 2013) to almost 70% for a long-term unemployed single earner with median income (see Seeleib-Kaiser, 2016). Given the large differences in the assumed reductions of the replacement rate, it is not surprising that Krause and Uhlig (2012), Krebs and Scheffel (2013) and Launov and Wälde (2013) find very different results.

Against this background, our paper proposes a novel methodology how to evaluate the macroeconomic effects of the Hartz IV reform, which is based on a distinction between a partial effect and an equilibrium effect. Both effects are evaluated through the lens of a suitable macroeconomic search and matching model of the labor market and empirically pinned down with new data from the IAB Job Vacancy Survey.

We argue that it is important to understand the different nature of partial and equilibrium effects. A lower replacement rate for long-term unemployed lowers the expected value of unemployment. As workers' outside option declines, their wages should drop and their transition rates from unemployment to employment should increase. This effect can be expected to be particularly strong for workers who are already unemployed or who are approaching long-term unemployment. This partial effect can be measured using microeconomic data and was documented recently by Price (2016).

In addition, there is an equilibrium effect, which is standard in search and matching models of the labor market (e.g. Mortensen and Pissarides, 1994; Pissarides, 2000). Due to lower wages, firms' incentives to post vacancies

Figure 1: Registered Unemployment Rate (West Germany), 1969-2016.

increases. More vacancies increase the probability for all workers to get in contact with a firm and thereby the likelihood of all workers to make a match.

We propose a suitable search and matching framework that models different durations of unemployment and that contains both partial and equilibrium effects. Firms and workers get in contact with one another according to a standard Cobb-Douglas constant returns contact function. Upon contact, worker-firm pairs draw an idiosyncratic training cost shock. Only workers below a certain training cost threshold will be selected (see Chugh and Merkl, 2016; Kohlbrecher et al., 2016). When certain groups in the economy are willing to work for a lower wage (due to lower long-term unemployment benefit compensation), firms are willing to hire workers with larger idiosyncratic training costs in these groups. In different words, their selection rate increases (partial effect). In addition, firms post more vacancies in reaction to the reform (equilibrium effect).

We use the IAB Job Vacancy Survey, which is a representative survey among up to 14,000 firms, to construct a time series for labor selection (i.e. the average share of workers selected) over the business cycle. This time series allows us to estimate the partial effect of the Hartz IV reform and offers several advantages over alternative outcome variables. In contrast to the job-finding rate, the selection rate is not affected by the redefinition of unemployment in 2005. In addition, in our model, labor market reforms that affect the matching efficiency, such as the reform of the Federal Employment Agency as part of Hartz III (see e.g. Hertweck and Sigrist, 2013; Launov and

Wälde, 2016), have no direct effect on the selection rate as contacts have already been established at this stage.[1] The same argumentation also applies for changes of market tightness. This means that the selection rate is largely isolated from the equilibrium effect and therefore allows for a relatively clean identification of the partial effect. We use an indirect inference approach and calibrate our model to replicate the partial effect estimated from the IAB Job Vacancy Survey. We also compare our model to the effects estimated by Price (2016) and obtain a similar order of magnitude.

In order to discipline our calibration with regard to the relative importance of the partial and the equilibrium effect, we further use the time series data on the job-finding rate and the selection rate. The job-finding rate in our model is the product of the contact rate and the selection rate. By regressing both the job-finding and the selection rate on market tightness, we find that the selection rate can account for about one half of the overall movements of the job-finding rate over the business cycle. We impose that our model follows the same dynamics as the data.

Overall, our calibrated model suggests that the German unemployment rate dropped by 3.1 percentage points due to Hartz IV. Roughly half of this effect is due to the partial effect, whereas the other half is due to the equilibrium effect. This shows that an evaluation that is based on microeconometric estimations only captures half of the relevant effects.

Our model further allows us to perform various counterfactual exercises. Interestingly, during the three years after the reform, we obtain a similar shift of the Beveridge curve as observed in the data from 2005 to 2007. This confirms that our model generates plausible results and that the Hartz IV reform was an important driver of the observed labor market dynamics.

Furthermore, our results are well in line with recent microeconometric evaluations of the Hartz IV reform (see e.g. Price, 2016). Our model endogenously generates a larger increase of the selection rate (and hence job-finding rate) the closer workers get to the expiration of short-term benefits (i.e. the longer workers are unemployed). In addition, abstracting from equilibrium effects, the probability of reemployment within 12 month after a job-loss increases by 3.1 percentage points in our model and the average wage (measured as the average wage over the employment spell) for long-term unemployed drops by 3%. In both cases, the order of magnitude of these responses is comparable to those found by Price (2016) who uses rich adminstrative worker data and a microeconometric approach to identify the partial effect

[1]The possibilities to evaluate the macroeconomic effects of Hartz IV from a pure macroeconometric perspective are limited. Hartz IV was the final step of a sequence of labor market reforms, which were implemented in between 2003 and 2005 (see Appendix for details). On top of this, the definition of unemployment was changed in 2005. Additional groups were included into the pool of the unemployed. However, they were only added in a sequence of several months and the estimates on the upward effects are diverse.

of Hartz IV causally. Our paper complements the worker-level evidence by Price (2016) from the firm side. In addition, our paper quantifies the equilibrium effect and offers additional counterfactual macroeconomic evaluations.

Besides quantifying the macroeconomic effects of the Hartz IV reform, our paper disentangles the relative role of contact versus selection over the business cycle for Germany. This is complementary to Kohlbrecher et al. (2016) who did a similar exercise based on microeconomic wage data. Interestingly, although the two methodological approaches are very different, the relative contribution of contacts and selection are similar. Understanding the importance of these two margins is both important from a business cycle and a policy perspective. Kohlbrecher and Merkl (2016) show for example that the selection margin may generate highly nonlinear responses to large aggregate shocks.

The rest of the paper proceeds as follows. Section 2 briefly outlines the institutional background on Hartz IV and the consequences for the replacement rate of different population groups. Section 3 derives a suitable search and matching model with labor selection, which allows us to look at the data in a structural way. Section 4 explains our identification strategy for the partial and equilibrium effects and provides empirical results. Section 5 explains the calibration of the contact function and the selection mechanism. Section 6 shows the aggregate partial and equilibrium effects of Hartz IV and performs several counterfactual exercises. Section 7 concludes.

2 The Reform of the Benefits and its Consequences

Before the reform of the unemployment benefit system (Hartz IV), the German system used to have three layers. Short-term unemployed received Arbeitslosengeld (60% of the previous net wage without children and 67% with children), long-term unemployed received Arbeitslosenhilfe (53% without children and 57% with children). If these transfers were not sufficiently high or if unemployed workers did not have a sufficiently long employment history, they obtained the means tested Sozialhilfe. As part of the reform, Arbeitslosenhilfe and Sozialhilfe were merged to Arbeitslosengeld II (ALG II), which is purely means tested.[2] Thus, the system was merged into two pillars. As illustrated by Figure 2, recipients of ALG II obtained a transfer of 345 Euro in 2005 plus a reimbursement of their rent (up to a certain limit). However, if the spouse earns a sufficiently high income or if the wealth is above a certain threshold, there is no eligibility for ALG II. As a rule of thumb, the cut of benefits is larger for higher income and higher wealth households. The former face a large drop because the new system switched from a system that was proportional to the last income to a fixed amount.

[2]The Hartz IV was part of a broader reform agenda. For an overview of the Hartz reforms see Appendix A.

The latter face a large drop because they may simply be ineligible until they run down their wealth to a certain level. This explains why it is difficult to quantify the decline of the replacement rate due to Hartz IV. Some groups face a strong decline of the replacement rate. A single median income earner faced a drop of 69% according to the OECD Tax-Benefit Calculator (Seeleib-Kaiser, 2016). By contrast, some low income households actually saw a slight increase of their income situation.[3] It is very difficult to weigh these groups properly because the low-skill workers are overrepresented in the pool of unemployed and they are affected least by the reform. By contrast, the high income workers may never touch the pool of (long-term) unemployed. However, the reform affects their surplus from working to not working by a lot. Thereby, we can expect that their behavior is also affected strongly by the labor market reform.

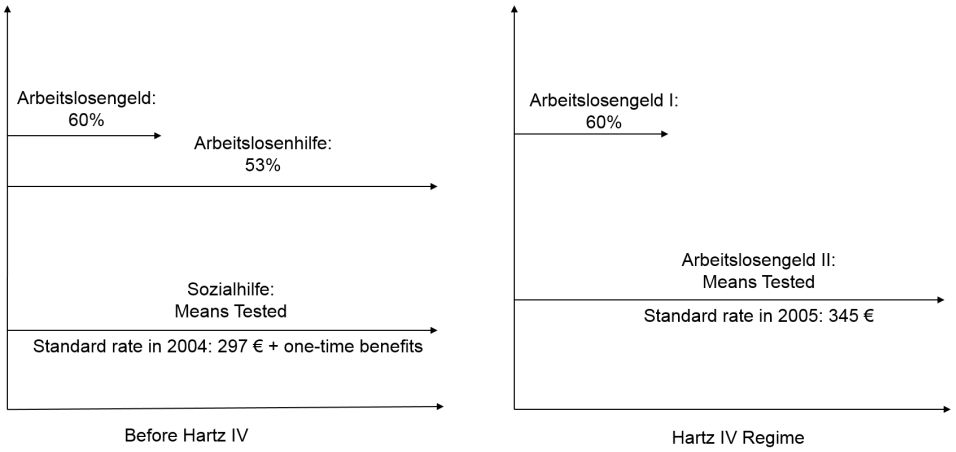

Figure 2: Illustration of the Hartz IV Reform for single households.

For macroeconomic evaluations, the actual decline of the net replacement rate is decisive for the effects on unemployment. Given the mentioned difficulties in quantifying this drop, we use an outcome variable that is directly affected by a different unemployment benefits system, namely the share of workers that is selected by firms. To set the stage for this quantitative exercise, the next section will describe a suitable theoretical framework.

[3]Krebs and Scheffel (2013) use a decline of 20% for the replacement rate of long-term unemployed in their counterfactual simulation. In Krause and Uhlig (2012) the reduction is around 24% for low-skilled workers and around 67% for high-skilled workers By contrast, Launov and Wälde (2013) use a decline of 7%. This is the key reason for their different results.

3 The Model

We use a version of the Diamond-Mortensen-Pissarides (DMP) model (e.g. Pissarides, 2000, Ch.1) in discrete time and enrich it with idiosyncratic training costs for new hires. There is a continuum of workers on the unit interval who can either be employed or unemployed. Unemployed workers randomly search for jobs on a single labor market and receive unemployment compensation b_s during the first 12 months of any unemployment spell (i.e. short-term unemployment benefits) and b_l afterwards (i.e. long-term unemployment benefits). Employed workers can lose their job with constant probability ϕ. Unemployed workers are indexed by the letter d, where $d \in \{0, ..., 12\}$ denotes the time left in months that a worker is still eligible for short-term unemployment benefits b_s. Therefore, a worker who has just lost a job receives the index 12, while a worker indexed by 0 is considered long-term unemployed. There is a fixed number of multi-worker firms on the unit interval indexed by i. Firms have to post vacancies in order to get in contact with a worker and pay vacancy posting costs κ per vacancy. We assume free-entry of vacancies. Contacts between searching workers and firms are established via a standard Cobb-Douglas contact function. While all workers search on the same market, the contact efficiency of workers may depend on the duration of unemployment. In addition, workers vary in the amount of training they require for a specific vacancy. Technically, firms and workers draw a match-specific realization ε from an idiosyncratic training costs distribution with density $f(\varepsilon)$ and cumulative density $F(\varepsilon)$. We assume a fixed training cost component tc^d that reflects that the average training required upon re-employment might depend on the duration of the prior unemployment spell.[4] This is consistent with the idea that human capital depreciates during unemployment. Only contacts with sufficiently low training costs, $\varepsilon \leq \tilde{\varepsilon}^d_{it}$ will result in a hire, where $\tilde{\varepsilon}^d_{it}$ is firm i's hiring cutoff and $\eta(\tilde{\varepsilon}^d_{it})$ is the firm's selection rate (i.e. the hiring probability for a given contact). Figure 3 illustrates graphically the main features of the model.

Our model is similar to that in Kohlbrecher et al. (2016) and to the stochastic job matching model (Pissarides, 2000, chapter 6) or many of the endogenous separation models (e.g. Krause and Lubik, 2007). Chugh and Merkl (2016) and Sedláček (2014) are further examples of labor selection models.

3.1 Firm's problem

Firms produce with a constant returns technology with labor as the only input. They post vacancies at a fixed cost κ per vacancy on a uniform labor

[4] We assume that the distribution of the idiosyncratic training cost distribution is the same for all worker types. Equivalently, we could let the mean of the distribution shift with duration of unemployment.

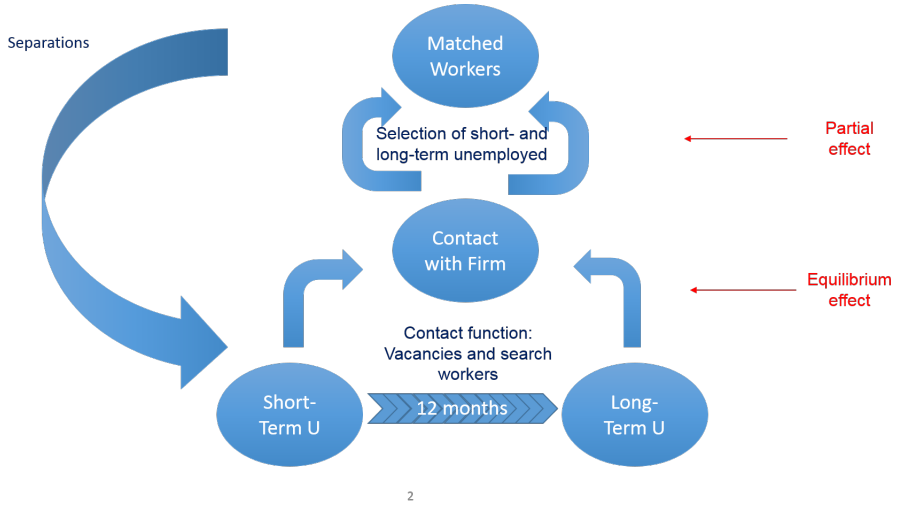

Figure 3: Graphical model description

market. The probability for a firm of hiring an unemployed worker indexed by duration d depends on three factors: the share of unemployed workers indexed by d among all the searching workers s_t^d, their respective search efficiency which translates into different contact probabilities for firms q_t^d, and the firm's selection rate, $\eta_{it}^d\left(\tilde{\varepsilon}_{it}^d\right)$, which depends on the firm's hiring cutoff $\tilde{\varepsilon}_{it}^d$.

The firm discounts the future with discount factor δ and chooses employment n_{it}, vacancies v_{it} and its hiring cutoffs $\tilde{\varepsilon}_{it}^d$ for all $d \in \{0, ..., 12\}$ to maximize the following intertemporal profit function:

$$E_0\left\{\sum_{t=0}^{\infty}\delta^t\left[\begin{array}{c} a_t n_{it} - w_t^I(1-\phi)n_{i,t-1} - \kappa v_{it} \\ -v_{it}\sum_{d=0}^{12} s_t^d q_t^d \eta(\tilde{\varepsilon}_{it}^d)\left(\hat{w}(\tilde{\varepsilon}_{it}^d) + \hat{H}(\tilde{\varepsilon}_{it}^d) + tc^d\right) \end{array}\right]\right\}, \quad (1)$$

subject to the evolution of the firm's employment stock in every period:

$$n_{it} = (1-\phi)n_{i,t-1} + v_{it}\sum_{d=0}^{12} s_t^d q_t^d \eta(\tilde{\varepsilon}_{it}^d), \quad (2)$$

where a_t ist aggregate productivity, w_t^I is the wage for incumbent workers (who do not require any training), and $\hat{w}$ and $\hat{H}$ denote the expectation of the wage and the idiosyncratic training costs realization conditional on hiring. More specifically,

$$\hat{w}(\tilde{\varepsilon}_{it}^d) = \frac{\int_{-\infty}^{\tilde{\varepsilon}_{it}^d} w_t^d(\varepsilon) f(\varepsilon) d\varepsilon}{\eta(\tilde{\varepsilon}_{it}^d)}, \quad (3)$$

and

$$\hat{H}(\tilde{\varepsilon}_{it}^{d}) = \frac{\int_{-\infty}^{\tilde{\varepsilon}_{it}^{d}} \varepsilon f(\varepsilon) d\varepsilon}{\eta(\tilde{\varepsilon}_{it}^{d})}. \tag{4}$$

The selection rate for workers with duration index d is:

$$\eta_{it}^{d} = \int_{-\infty}^{\tilde{\varepsilon}_{it}^{d}} f(\varepsilon) d\varepsilon \quad \forall d. \tag{5}$$

Let π_{it}^{I} and π_{it}^{d} denote the firm's discounted profit at time t for an incumbent worker (indexed by I) and for a newly hired worker with remaining short-term unemployment benefits eligibility d.

$$\pi_{it}^{I} = a_t - w_{it}^{I} + \delta(1-\phi) E_t \pi_{i,t+1}^{I} \tag{6}$$

$$\pi_{it}^{d} = a_t - w_t^{d}(\varepsilon) - \varepsilon - tc^{d} + \delta(1-\phi) E_t \pi_{i,t+1}^{I} \tag{7}$$

Taking first order conditions of equation (1) with respect to employment n_{it}, vacancies v_{it}, and the hiring cutoffs $\tilde{\varepsilon}_{it}^{d}$ and rearranging yields the following optimality conditions for the firm:

$$\tilde{\varepsilon}_{it}^{d} = a_t - w(\tilde{\varepsilon}_{it}^{d}) - tc^{j} + \delta(1-\phi) E_t \pi_{i,t+1}^{I} \quad \forall d \tag{8}$$

and

$$\kappa = \sum_{j=0}^{12} s_t^{d} q_t^{d} \eta_{it}^{d} \hat{\pi}_{it}^{d}, \tag{9}$$

where hat variables again denote the expectation of profits conditional on hiring. As firms are ex-ante identical, they all choose the same hiring cutoff and hence selection probability. We can therefore write:

$$\tilde{\varepsilon}_{t}^{d} = a_t - w(\tilde{\varepsilon}_{t}^{d}) - tc^{j} + \delta(1-\phi) E_t \pi_{t+1}^{I} \quad \forall d, \tag{10}$$

and

$$\kappa = \sum_{j=0}^{12} s_t^{d} q_t^{d} \eta_{t}^{d} \hat{\pi}_{t}^{d}. \tag{11}$$

The aggregate selection rate for workers with duration index d is:

$$\eta_{t}^{d} = \int_{-\infty}^{\tilde{\varepsilon}_{t}^{d}} f(\varepsilon) d\varepsilon \quad \forall d. \tag{12}$$

3.2 Worker's problem

Workers have linear utility over consumption and discount the future with discount factor δ. Once separated from a job, a worker is entitled to 12 months of short term unemployment benefits b_s and long term unemployment benefits b_l afterwards, with $b_s > b_l$.

The value of unemployment therefore depends on the remaining months a worker is eligible of short term unemployment benefits. For a short-term unemployed (i.e. $d = 1 : 12$) the value of unemployment is given by:

$$U_t^d = b^S + \delta E_t \left[p_{t+1}^{d-1} \eta_{t+1}^{d-1} \hat{V}_{t+1}^{d-1} + (1 - p_{t+1}^{d-1} \eta_{t+1}^{d-1}) U_{t+1}^{d-1} \right]. \tag{13}$$

In the current period, the short-term unemployed receives benefits b_s. In the next period, she either finds a job or remains unemployed. In the latter case the time left in short-term unemployment d is reduced by a month. The probability of finding employment in the next period will depend on the next period's contact probability and selection rate, both of which can depend on unemployment duration which again is higher in the next period (i.e. d will be lower). If the worker finds a job, the value of employment is denoted by V_t^d, which due to wage bargaining depends on the workers outside option and is therefore also indexed by d. Again, a hat indicates an evaluation of the variable at the conditional expectation of the training costs realization.

After 12 months the worker receives the lower long-term unemployment benefits b_l indefinitely or until she finds a job:

$$U_t^0 = b^L + \delta E_t \left[p_{t+1}^0 \eta_{t+1}^0 \hat{V}_{t+1}^0 + (1 - p_{t+1}^0 \eta_{t+1}^0) U_{t+1}^0 \right]. \tag{14}$$

Due to the different outside options reflected in the wage, the value of work for an entrant depends on the remaining months she is eligible for short term benefits and - through the wage - on the realization of the idiosyncratic training cost:

$$V_t^d(\varepsilon) = w_t^d(\varepsilon) + \delta E_t \left[(1 - \phi) V_{t+1}^I + \phi U_{t+1}^I \right]. \tag{15}$$

We allow for the possibility of immediate rehiring. The resulting value of work for an incumbent worker I is:

$$V_t^I = w_t^I + \delta E_t \left[(1 - \phi) V_{t+1}^I + \phi U_{t+1}^I \right], \tag{16}$$

where U_t^I denotes the outside option for an incumbent worker, in case that wage negotiations fail:

$$U_t^I = p_t^{12} \eta_t^{12} \hat{V}_t^{12} + (1 - p_t^{12} \eta_t^{12}) U_t^{12}. \tag{17}$$

3.3 Unemployment dynamics

The total number of unemployment in period t after matching has taken place is the sum over all ($d \in \{0, ..., 12\}$) unemployment states:

$$u_t = \sum_{d=0}^{12} u_t^d = 1 - n_t. \tag{18}$$

The number of unemployed with 12 remaining months of short term benefits is determined by the workers that have been separated at the end of last period and were not immediately rehired:

$$u_t^{12} = \phi(1 - p_t^{12}\eta_t^{12})n_{t-1}. \tag{19}$$

The number of unemployed with remaining eligibility $d = 1 : 11$, is determined by last period's unemployed who have not been matched in the current period:

$$u_t^d = (1 - p_t^d\eta_t^d)u_{t-1}^{d+1}. \tag{20}$$

The number of long-term unemployed consists of the unemployed who received short-term benefits in the last period for the last time as well as previous period's long term unemployed that have not been matched:

$$u_t^0 = (1 - p_t^0\eta_t^0)(u_{t-1}^1 + u_{t-1}^0). \tag{21}$$

The number of searching workers at the beginning of period t (before matching has taken place) is therefore:

$$us_t = \phi n_{t-1} + u_{t-1}. \tag{22}$$

The share of searching workers with remaining short term unemployment eligibility of $d = 0 : 12$ months among all searchers is therefore:

$$s_t^{12} = \frac{\phi n_{t-1}}{us_t}, \tag{23}$$

for newly separated workers,

$$s_t^d = \frac{u_{t-1}^{d+1}}{us_t}, \tag{24}$$

for $d = 1 : 11$ and

$$s_t^0 = \frac{u_{t-1}^1 + u_{t-1}^0}{us_t} \tag{25}$$

for long term unemployed.

Contacts between searching workers and firms are established via a Cobb-Douglas, constant returns to scale (CRS) contact function

$$c_t = \mu_t^d v_t^\gamma us_t^{1-\gamma}, \tag{26}$$

where us_t are the number of searching workers at the beginning of period t, v_t is the vacancy stock, c_t is the overall number of contacts in period t, and μ_t^d is the contact efficiency that may depend on the duration of unemployment. The contact probability for a worker and for a firm are therefore:

$$p_t(\theta_t) = \mu_t^d \theta_t^{\gamma}, \tag{27}$$

and

$$q_t(\theta_t) = \mu_t^d \theta_t^{\gamma-1}, \tag{28}$$

with $\theta_t = \frac{v_t}{us_t}$.

3.4 Wage

We assume individual Nash bargaining for both new and existing matches. Workers and firms bargain over the joint surplus of a match, where workers' bargaining power is α and firms' bargaining power is $(1-\alpha)$ The Nash bargained wage therefore solves the following problems:

The wage for an incumbent worker solves:

$$w_t^I \in \arg\max \left(V_t^I - U_t^I\right)^{\alpha} \left(\pi_t^I\right)^{1-\alpha} \tag{29}$$

Equivalently, the wage for an entrant worker solves:

$$w_t^d \in \arg\max \left(V_t^d(\varepsilon) - U_t^d\right)^{\alpha} \left(\pi_t^d(\varepsilon)\right)^{1-\alpha} \tag{30}$$

4 Identification Strategy

The German Hartz IV reform reduced the replacement rate for long-term unemployed. Less generous unemployment benefits decrease workers' fallback option in our model. The closer unemployed workers come to the expiration of short-term benefits, the lower will be the value of unemployment and the lower will be their reservation wage. This leads to lower wages in the Nash bargaining solution.

A lower wage initiates two effects in our model. First, there is an equilibrium effect, which is well known from search and matching models (e.g. Pissarides, 2000). Lower wages increase firms' expected surplus from posting a vacancy. Due to the free-entry condition of vacancies, firms post vacancies until the expected value from posting a vacancy is zero. More vacancies in the economy increase the number of contacts (due to the contact function) and thereby increase workers' probability to get in contact with a firm.

In addition, there is a partial effect in our model. As the wage decreases, firms will hire workers with higher idiosyncratic training costs (or more generally lower idiosyncratic productivity). Firms select a larger fraction of applicants who got in contact with them through the contact function.

When all firms act symmetrically, the average number of applicants per hire declines (more details below).

The existing literature on the macroeconomic effects of Hartz IV (Krause and Uhlig, 2012; Krebs and Scheffel, 2013; Launov and Wälde, 2013) uses the decline of the replacement rate for long-term unemployed as an input to quantify the reform implications. However, as shown in Section 2, there is strong disagreement on how much the replacement rate actually declined because this differed depending on the previous wage and family characteristics.

Therefore, our paper proposes a new identification strategy how to measure the effect of Hartz IV. Microeconomic data allows us to directly estimate the partial effect in a firm-level dataset. The equilibrium effect can then be identified by looking at the interplay of partial and equilibrium effect over the business cycle.

4.1 Identifying the Equilibrium Effect

It is very difficult to measure the equilibrium effect of the Hartz IV reforms directly based on time series data. Several other labor market reforms (namely, Hartz I, II, and III) were implemented in 2003 and 2004, i.e. briefly before the Hartz IV reform. In addition, the measure of unemployed workers was redefined in 2005. Thus, the time series contains a structural break in 2005, i.e. exactly at the time of the Hartz IV reform. These two issues put serious limits on the ability of pure time series methods to identify the reform effects.

We therefore do not aim at measuring the equilibrium effect of Hartz IV directly. Instead, we will identify the reform effect based on empirical information on the partial response and use our knowledge on the relative importance of partial and equilibrium effects over the business cycle. We identify the latter based on our model framework and time series data. The dynamics of the job-finding rate over the business cycle is the product of the contact rate and the selection rate. Thus, in terms of log-deviations, these two effects are additive:

$$\hat{jfr}_t = \hat{p}_t + \hat{\eta}_t, \tag{31}$$

where hats denote log-deviations from steady state.

When aggregate productivity increases, firms have additional incentives to post more vacancies (equilibrium effect) and to select a larger fraction of applicants (partial effect). Therefore, the elasticity of the aggregate job-finding rate with respect to market tightness (or any other aggregate variable) is approximately equal to the elasticity of the contact rate with respect to market tightness plus the elasticity of the selection rate with respect to

market tightness.[5]

We use the dynamics of the job-finding rate (based on the administrative data) and the selection rate (based on the IAB Job Vacancy Survey) over the business cycle to identify the relative importance of the two components (contact vis-à-vis selection).

We are the first to construct a time series for selection over the business cycle. The IAB Job Vacancy Survey asks firms about the number of suitable applicants for their last hire. The question is well in line with our model. Obviously, given that firms are asked about the number of *suitable applicants*,[6] firms must have screened these candidates in some way (e.g. by checking the application package or by inviting the applicant for an interview). Thus, we can calculate the average probability of a worker (who got in contact with a firm) to be selected as the inverse of the number of suitable applicants for the last hire. We need to assure that the surveyed last hires are representative for the entire economy. Therefore, we use representative survey weights to aggregate the selection rate to different aggregation levels (national, state, and industry).

Figure 4 shows the movement of the job-finding rate, selection rate and market tightness from 1992 to 2014. We normalized all three time series to an average of 1 to make relative movements better visible. It can be seen that market tightness shows much larger fluctuations than the job-finding rate and the selection rate. This is well in line with our model. Kohlbrecher et al. (2016) show that the selection rate comoves procyclically (but less than proportionally) with market tightness in a selection model.

To determine the relative importance of the selection and contact margin for the job-finding rate, we now estimate the elasticity of the job-finding rate and the selection rate with respect to market tightness:

$$\ln Y_t = \beta_0 + \beta_1 D_t^{Hartz\ IV} + \beta_2 \ln \theta_t + + \varepsilon_t, \tag{32}$$

where the dependent variable is either the logarithm of the job-finding rate or the logarithm of the selection rate. Those are further regressed on a shift dummy that is 1 from 2005 onwards ($D_t^{Hartz\ IV}$) to account for differences in the job-finding rate and selection rate before and after Hartz IV (see Section 4.1). Due to data availability, we perform the estimation on an annual basis for the sample range 1992 to 2015. In a robustness check, we also perform a fixed-effects panel estimation on West German state and industry level, which yields very similar results (see Appendix C.1).

The estimated elasticities are equal to 0.31 for the job-finding rate, and 0.15 for the selection rate (see Table 1). Our paper is the first to estimate

[5]Formally, the effects of changes in market tightness (or other aggregate variables) are transmitted via changes of the contact and selection rate $\frac{\partial \ln jfr_t}{\partial \ln \theta_t} \approx \frac{\partial \ln p_t}{\partial \ln \theta_t} + \frac{\partial \ln \eta_t}{\partial \ln \theta_t}$.

[6]In the most recent waves of the survey, firms are also asked about the overall number of applicants. This number is on average substantially higher.

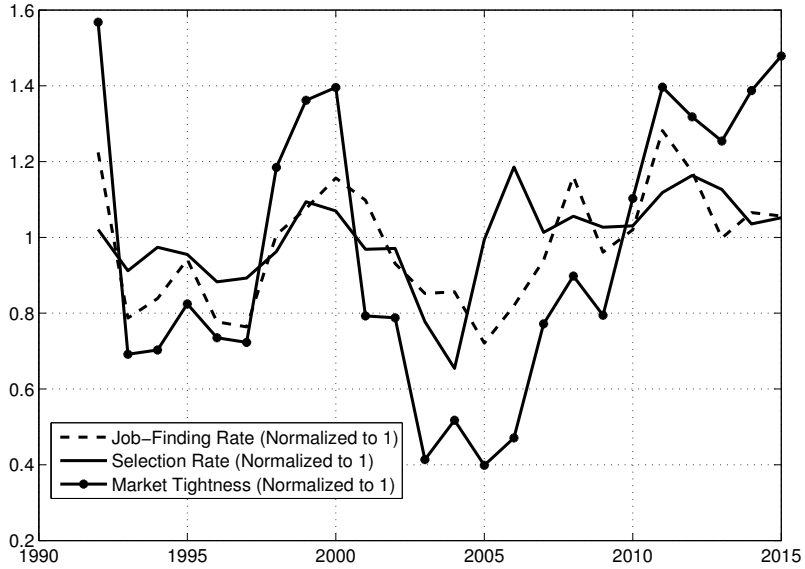

Figure 4: German Labor Market Dynamics, 1992-2013.

the elasticity of the selection rate based on the IAB-Job Vacancy Survey and thereby to quantify the contribution of the selection margin for the behavior of the job-finding rate over the business cycle.

Two things are worth pointing out in this context. First, the estimated elasticity of the job-finding rate with respect to market tightness is well in line with Kohlbrecher et al. (2016) who estimate a matching function for Germany based on detailed administrative data. Second, as predicted by equation (31), the elasticity of the selection rate with respect to market tightness is smaller than the elasticity of the job-finding rate.[7] Thus, the dynamics of the job-finding rate is both driven by contact and selection. To be more precise, about one half of the dynamics of the job-finding rate is driven by the selection rate and about one half is driven by the contact rate. The partial and the equilibrium effects are of roughly similar size. The estimated elasticities of the job-finding rate and the selection rate will be important targets in our calibration below and - for a given response of the selection rate to the Hartz IV reform - discipline the equilibrium effect.

[7] If the inverse was true, the contact rate would have to be countercyclical. This would stand in contradiction to standard contact functions.

	Dependent variable:	
	log(selection rate)	log(job-finding rate)
	(1)	(2)
Hartz IV-Dummy	0.13***	0.02
	(0.04)	(0.05)
log(market_tightness)	0.15***	0.31***
	(0.05)	(0.07)
Constant	−0.56***	−2.54***
	(0.09)	(0.07)
Observations	24	24
R^2	0.54	0.53
Adjusted R^2	0.50	0.49
Residual Std. Error (df = 21)	0.09	0.13
F Statistic (df = 2; 21)	12.50***	12.05***

*Note: Estimation by OLS with Newey-West standard errors; *p<0.1; **p<0.05; ***p<0.01*

Table 1: Regression results for West Germany, 1992-2015.

Identifying the Partial Effect

Our new time series for the selection rate allows us to estimate the partial equilibrium effect for the Hartz IV reform. Visual inspection of Figure 4 shows that the selection rate increased substantially in 2005 when the Hartz IV reform was implemented. We have argued before that it is very difficult to estimate the effects of Hartz IV based on the data on unemployment and the job-finding rate. We will argue in the following that the selection rate is a much better candidate. First, the selection rate is derived from the IAB Job Vacancy Survey and is therefore not affected by the change of the unemployment definition in the administrative data.[8] Second, the selection rate is not directly affected by labor market reforms that improve the matching efficiency. Launov and Wälde (2016), for example, argue that the reform of the Federal Employment Agency has increased the matching efficiency in Germany substantially and is therefore a key contributor for the decline of unemployment in Germany. In our model, selection takes place after contacts between workers and firms were established. Thus, there is no direct effect from a higher matching efficiency on the selection rate. There is, of course, an indirect effect. An improved labor market situation due

[8]The job-finding rate is affected because it is calculated by dividing the number of matches from administrative data by unemployment. With the redefinition, some workers were included in the unemployment pool that had not been counted as unemployed before. This explains why the job-finding rate first drops in 2005.

to a higher matching efficiency increases the fallback option of workers and thereby the wage. Figure C.1 in the appendix shows that a positive shock to the matching efficiency has a very small but negative effect on the selection rate. In this case, we obtain a lower bound when we estimate the partial effect.

In order to estimate the partial effects of Hartz IV on the selection rate, we use a shift dummy that takes the value of 1 from 2005 onwards. Table 1 shows that the selection rate has increased by 13% after the reform. The estimated coefficient is statistically significantly different from zero at the 1% level. Note that we condition in the estimation on the value of market tightness. Table C.1 Appendix we show that the results are very similar if we estimate on a more disaggregate level (i.e. the state and industry level).

The estimated partial effect of Hartz IV will be imposed in our calibration. In different words, in our simulation exercise, we will reduce the unemployment benefits by the amount necessary to obtain a 13% increase in the aggregate selection rate. This is very different from existing macroeconomic studies that use the replacement rate reduction from external sources (Krause and Uhlig, 2012; Krebs and Scheffel, 2013; Launov and Wälde, 2013).

It is worthwhile to reflect on the reaction of the selection rate due to Hartz IV. Remember that we have calculated the selection rate as the inverse of the number of applicants for the last hire. Does an increase of the selection rate mean that the number of applicants went down due to Hartz IV? In this context, it is important to differentiate between the overall number of applicants and the average number of applicants for the last position. In our model, the overall number of applicants is the number of searching workers multiplied with the probability of having a contact with a firm. Figure C.2 in the Appendix shows that due to the equilibrium effect the overall number of applicants increases in the immediate aftermath of an unemployment benefit cut while the number of applicants per hire (i.e. the inverse of the selection rate) goes down permanently. The first result we would also expect in a standard search and matching model without selection. In this case, however, the relationship between hires and contacts (i.e. applicants) is fixed and the number of applicants per hire would not change. With selection, however, hires will increase more than proportionally because a higher share of applicants will be selected due to the reform. The ratio of applicants per hire goes down. This is exactly what we observe in the data.

Finally, the relationship between the change in benefits and the resulting response of the selection rate in our model will to a large extend depend on our assumptions about the distribution of idiosyncratic training costs. Kohlbrecher et al. (2016) show in the context of a similar model structure[9]

[9]Kohlbrecher et al. (2016) use a model with contact and selection. However, they do not distinguish between different unemployment durations nor do they analyze the effects of labor market reforms.

that the elasticity of the selection rate over the business cycle - which we have estimated - is a function of the distribution of training costs (or more general idiosyncratic productivity) at the hiring cutoff point. They derive the following analytical steady state equation, which is also a good approximation for dynamic fluctuations:[10]

$$\frac{\partial \ln \eta}{\partial \ln \theta} = \frac{f\left(\tilde{\varepsilon}\right)}{\eta}\left(\tilde{\varepsilon} - \frac{\int_{-\infty}^{\tilde{\varepsilon}} \varepsilon f\left(\varepsilon\right) d\varepsilon}{\eta}\right). \tag{33}$$

Thus, for a given underlying distributional shape of the idiosyncratic training costs and a given cutoff point,[11] the estimated elasticity of the selection rate with respect to market tightness ($\partial \ln \eta / \partial \ln \theta$) pins down the dispersion of the underlying idiosyncratic distribution. This insight will be used in the calibration below.

5 Calibration

We calibrate the model to West-German data from 1992 to 2015.[12] We choose a monthly frequency with a discount factor of $0.99^{\frac{1}{3}}$ and normalize aggregate productivity to 1. Furthermore, we assume that firms and households have equal bargaining power (i.e. $\alpha = 0.5$). The short-term unemployed in Germany receive unemployment benefits that amount to 60% or 67% of the last net wage, the long-term unemployed received 53% or 57% prior to the Hartz IV reform. As the unemployed may also enjoy some home production or utility from leisure, we choose the upper bound of the legal replacement rates for our calibration. We set the replacement rates to 67% and 57% of the steady state incumbent wage in our model. We set the monthly separation rate to 2% to target a steady state unemployment rate of 10.9% (prior to Hartz IV).[13] We target a steady state market tightness of 0.25, which pins down the value of the vacancy posting costs.

The rest of the parameters are pinned down by six additional targets that we can measure in the data: The exit rates out of short-term and long-term unemployment, the aggregate selection rate, the relative contact rates

[10] Kohlbrecher et al. (2016) show that this equation holds for a broad class of selection models, such as idiosyncratic training costs, permanent idiosyncratic productivity shocks, and endogenous separation models in which the shock also hits in the first period.

[11] Remember that the selection rate is $\eta_t^d = \int_{-\infty}^{\tilde{\varepsilon}_t^d} f(\varepsilon) d\varepsilon$. The IAB Job Vacancy Survey provides a target for the selection rate and thereby pins down the cutoff point for a given distributional form.

[12] We restrict our analysis to West Germany, as we do not want our regressions to be distorted by labor market transition effects in East Germany at the beginning and middle of the 1990s. Note, however, that we obtain a similar partial Hartz IV effect when we estimate the effects for Germany as a whole.

[13] This corresponds to the unemployment rate in January 2005.

of long-term versus short-term unemployed, as well as the elasticity of both the selection rate and the job-finding rate with respect to market tightness.

Parameter/Target	Value	Source
Aggr. productivity	1	Normalization
Discount factor	$0.99^{\frac{1}{3}}$	Standard value
Short-term replacement rate	0.67	Legal replacement rate
Long-term replacement rate (pre-reform)	0.57	Legal replacement rate
Bargaining power	0.5	Standard value
Separation rate	0.02	Unemployment rate of 10.9%
Short-term job-finding rate	0.16	Klinger and Rothe (2012)
Long-term job-finding rate	0.07	Klinger and Rothe (2012)
Relative contact rate of long-term unemp.	0.45	PASS survey
Market tightness	0.25	IEB and Job Vacancy Survey
Selection rate	0.46	Job Vacancy Survey
$\partial \ln \eta / \partial \ln \theta$	0.15	IEB and Job Vacancy Survey
$\partial \ln jfr / \partial \ln \theta$	0.31	IEB and Job Vacancy Survey

Table 2: Parameters and Targets for Calibration.

According to Klinger and Rothe (2012) the pre-reform exit rates out of unemployment are 16% and 6.5% for short-term and long-term unemployed. In our model, this could be driven by both lower contact rates and lower selection rates over time. How can we differentiate between the two? We observe the average pre-reform selection rate form the Job Vacancy Survey, which is 46%, and take that as given. Unfortunately, we cannot differentiate selection rates for long-term and short-term unemployed with our firm dataset. We therefore use information contained in the IAB PASS survey.[14] In this survey, respondents are asked whether they have had a job interview during the last four weeks. We compute the contact rate as the share of respondents who answer this question affirmatively. It turns out, that the contact rate for ALG II recipients (i.e. long-term unemployed) is 45% of the contact rate for ALG I recipients (i.e. short-term unemployed). We accordingly set the contact efficiency of long-term unemployed to 45%. Together with the targeted aggregate selection rate and the exit rates for long- and short-term unemployed this pins down all the contact, selection, and job-finding rates in the economy. Note that while we assume that all short-term unemployed face the same contact, selection, and job-finding rate,[15] our calibration implies that the fixed training costs component increases every month with the duration of unemployment.[16]

[14] For a description of the IAB PASS survey, see Appendix B.

[15] While we observe different job-finding rates per month of short-term unemployment duration in the data, we cannot compute the corresponding contact rates.

[16] As the reservation wage falls with duration of unemployment, average training costs have to increase if we want to keep the steady state job-finding rates fixed.

We assume that idiosyncratic productivity follows a lognormal distribution. As shown by Kohlbrecher et al. (2016), in a selection model the elasticity of the selection rate with respect to market tightness is determined by the shape of the idiosyncratic productivity distribution at the cutoff point. Given the distribution, the cutoff point is in turn determined by the selection rate, which we have already targeted. We can therefore pin down the parameters of the distribution by targeting the elasticity of selection rate with respect to market tightness, which is 0.15 in our data. The resulting scale parameter of the distribution is 3.8.[17] The elasticity of the contact rate with respect to market tightness (i.e. the weight on vacancies in the contact function) is finally set to target the overall elasticity of the job-finding rate with respect to market tightness, which is 0.31 in the data. The resulting weight on vacancies in the contact function is 0.14. Thus, the selection mechanism accounts for about half of the elasticity of the job-finding rate with respect to market tightness in our model.

6 The Effects of Hartz IV

Our empirical study in Section 4 has shown that the reform resulted in a 13% increase in the selection rate. We therefore ask by how much the unemployment benefits for long-term unemployed had to fall, to produce this outcome. In our model, we require a 15.5% reduction. This is a value in between those used by Launov and Wälde (2013) on the one hand and Krause and Uhlig (2012) and Krebs and Scheffel (2013) on the other hand. Figure 5 shows the impulse responses of the selection rate in reaction to this permanent decline of the replacement rate for long-term unemployed.

The selection rate immediately increases on impact for all groups of searching workers. However, the effect is larger, the closer the unemployed get to the expiration of the more generous short-term benefits. For workers who have just been separated from a job (upper right panel in Figure 5), the reduction of long-term unemployment benefits affects their present value of unemployment by the least because they will only feel the reduction if they are not matched within the next twelve months. Still, their outside option falls, which increases the joint surplus of a match. The selection rate for workers who still have a full year of short-term benefits increases by around 7%. For workers who switch to the long-term benefit scheme in the next period, the reduction in long-term benefits has a larger effect on their outside option. Their selection rate increases by 21%. This is in line with empirical evidence that unemployed workers reservation wages and job-finding rates increase sharply near the expiration of benefits (see e.g. Price,

[17] Note that we fix the location parameter of the distribution at 0 and instead let the fixed training costs component to vary. This allows us to vary the mean of the training costs for different groups while preserving the shape of the distribution.

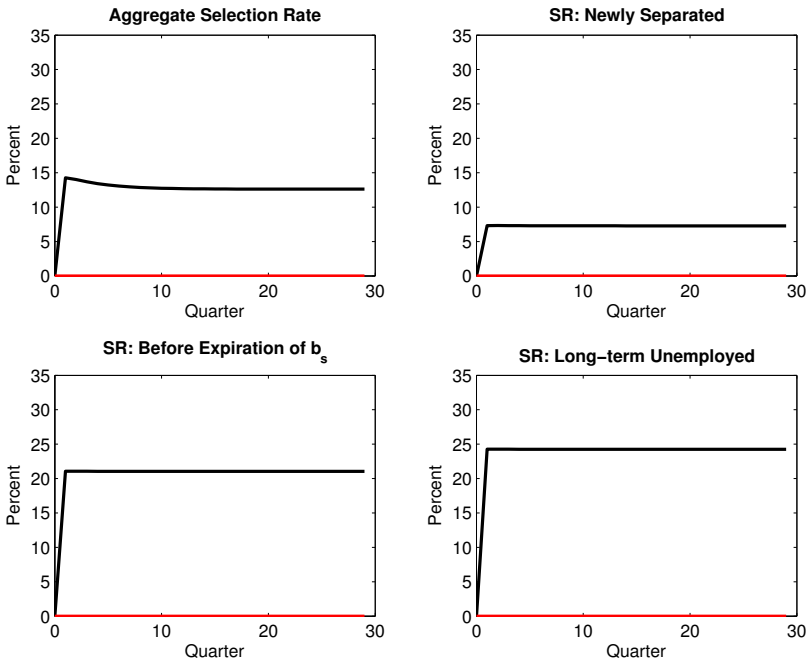

Figure 5: Selection rate (SR): impulse responses to a 15.5% decline in long-term unemployment benefits.

2016). Finally, the impact is largest for the long-term unemployed who are immediately affected by the reduction of long-term benefits. Their selection rate increases by 24%.[18] Figure 6 shows the impact responses of the selection rate in response to a decline in long-term unemployment benefits for the 12 groups of short-term unemployed (12 to 1 months of short-term benefits remaining) and long-term unemployed in percent deviation. The response of the selection rate increases gradually.

How do our results compare to other recent microeconometric studies of the Hartz IV reform? Price (2016) uses the German administrative data to estimate the causal effects of Hartz IV from the worker side. He finds that the probability of being reemployed within 12 month of beginning a claim increases by 4 percentage points for men and 5.8 percentage points for women. If we keep the contact rate constant,[19] we find an increase of the reemploy-

[18] While the individual selection rates all adjust on impact, the aggregate rate, which is a weighted average, slightly overshoots at the beginning. The reason is a composition effect. Initially, there are more long-term unemployed for whom the effect is largest. However, the difference between the initial response and the steady state response is small (around 1 pp).

[19] Per construction, the microeconometric study by Price (2016) does not capture any

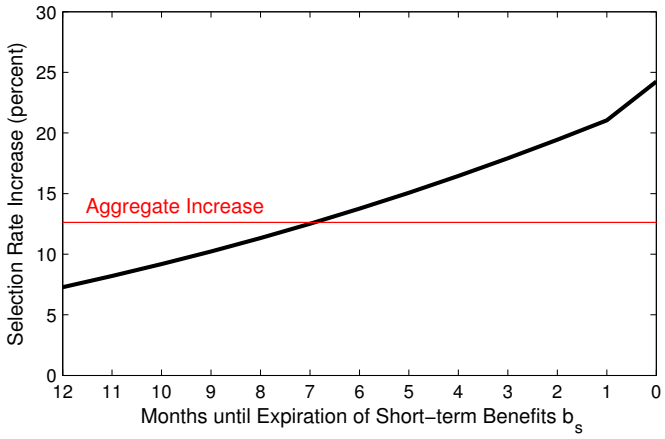

Figure 6: Impact responses of Selection Rate to a decline in long-term unemployment benefits by remaining months of b_s in percent.

ment hazard of 3.1 percentage points, which is smaller but close to Price' (2016) results. Furthermore, the magnitudes of the wage effects in our model are quite comparable.. In our model, the average wage over the employment spell for a reemployed worker who exhausted short-term benefits reduces by 3% due to Hartz IV. Price (2016) finds that those workers accept 4% - 8% lower wages on reemployment after the reform and conditional on jobless duration.[20] This is important as effects in our model run through the wage and there is some debate in the empirical literature as to whether benefits actually influence reemployment wages once controlling for unemployment duration. Schmieder et al. (2016), for example, find for the pre-Hartz period in Germany that the effect of benefit duration on wages is at best very small. However, they study a different time period and identify their effects based on age related differences in the maximum duration of short-term benefits. In the pre-Hartz period, however, upon exhaustion of short-term benefits, workers still received relatively generous long-term benefits. The Hartz IV reform, however, meant that entering long-term unemployment became a lot more painful which might explain why Price (2016) finds much larger effects on wages. Finally, it is important to stress that the similarity in results between our study and Price (2016) is quite comforting, given that we derive our partial effects based on completely different data sources: the administrative worker data (in the case of Price (2016)) and firm survey data (this study).

equilibrium effects. We therefore keep the contact rate constant when we compare our estimates.

[20] We cannot make this distinction in our model as there is a one to one relationship between duration and benefit eligibility.

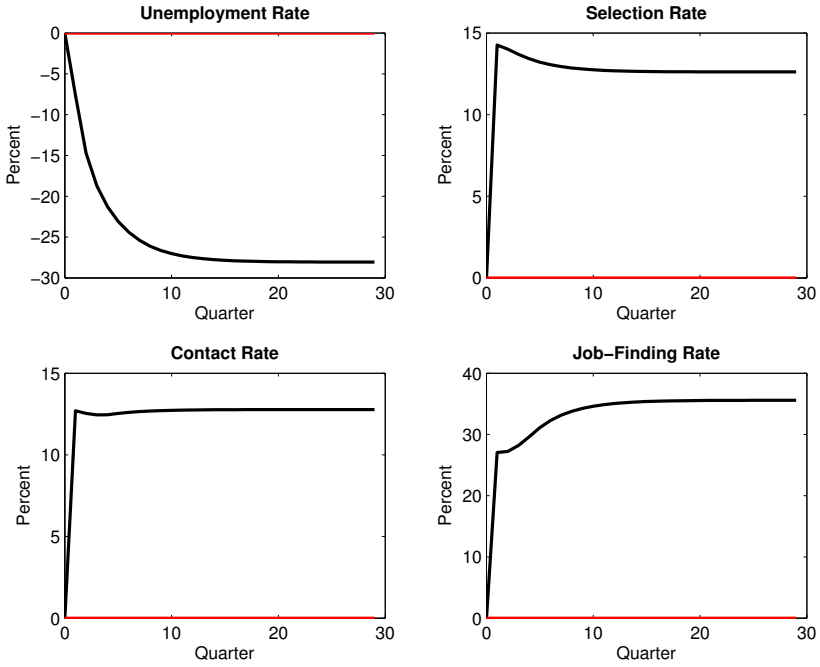

Figure 7: Impulse responses to a decline in long-term unemployment benefits.

One advantage of our model-based approach, however, is that it allows us to quantify the equilibrium effect. As firms' expected surplus rises, they post more vacancies. More vacancies increase the market tightness and thereby increase the probability of workers to get in contact with a firm (through the contact function). This is illustrated in the lower left panel of Figure 7. The contact rate for unemployed workers rises by nearly 13%.[21] The overall job-finding rate, which is the product of both the contact and the selection rates, increases by 27% on impact and is 35% higher in the new steady state (lower right panel of Figure 7). While the contact and selection rates adjust immediately, the job-finding rate increases quite sluggishly.[22] The reason is a composition effect. The aggregate job-finding rate is a weighted average of the job-finding rates of all searching workers. Due to the reform, the duration of unemployment is shortened. The share of the searching workers with long unemployment durations declines over time. The share of long-term unemployed is 12 percentage points lower in the new steady state. This illustrates why, from an econometric point of view, the time series

[21] As all workers search on the same labor market, the relative response of the contact rate to the reform is the same for short and long-term unemployed.

[22] The new steady state is only reached after 7 years.

of the selection rate is better suitable for the identification of the reform than the job-finding rate (in addition to the redefinition issue). Finally, the unemployment rate falls by 28%. This corresponds to a decrease of the unemployment rate by 3.1 percentage points in our calibration. Hence, the Hartz IV reform can account for around 50 percent of the decline in German unemployment. If we keep the contact rate constant, unemployment reduces by 1.6 percentage points. Thus, the partial effect can account for about half of the overall effect.

Finally, it is interesting to study the trajectory of the Beveridge curve in the data and in the model. Figure 8 shows the simulated Beveridge Curve in response to the decline of the replacement rate for long-term unemployed workers in our model. Vacancies increase, overshoot and end up at a level that is above the old steady state level. Unemployment sequentially declines to a lower long-run level.

We contrast our simulation results with the actual movement of the Beveridge Curve from the first quarter of 2005 to the fourth quarter of 2007 (Figure 9). Similar to the simulation, vacancies increase, overshoot somewhat and end up at a higher level.[23] Unemployment sequentially declines to a permanently lower level in the data. The movements are not only qualitatively comparable, but the quantitative reactions (as percent deviations) are also similar.

While the comparison of our simulation and the data is purely descriptive, given the similarities between the two, the exercise provides suggestive evidence for the importance of the Hartz IV reform for German labor market dynamics in the years after the reform. Overall, our work points to an important role of the reform of the benefit system for the decline of German unemployment. Other reforms (such as Hartz III) may also have contributed (e.g. Launov and Wälde, 2016). However, our methodology does not allow us to quantify these contributions.

7 Conclusion

This paper has proposed a novel approach how to evaluate the reform of the German unemployment benefits system in 2005. In contrast to earlier studies, we do not have to assume a certain decline of the replacement rate for long-term unemployed, for which the literature provides a wide range of estimates. Instead, we use information on firms' hiring behavior from the German Job Vacancy Survey and show that firms' hiring selectivity decreased following the Hartz IV reform. Based on our estimates, we calibrate the partial effect of the reform in a search and matching model with labor

[23] The overshooting behavior takes place later in the data and is somewhat less pronounced. Vacancies are a purely forward-looking variable in our model, while there may by reasons why they are more persistent in the data (e.g. convex vacancy posting costs).

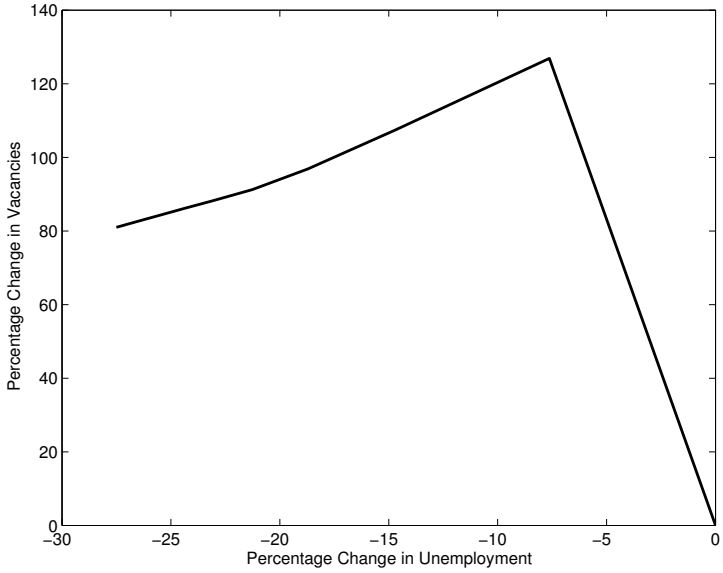

Figure 8: Beveridge curve generated by the model during first three years after the shock.

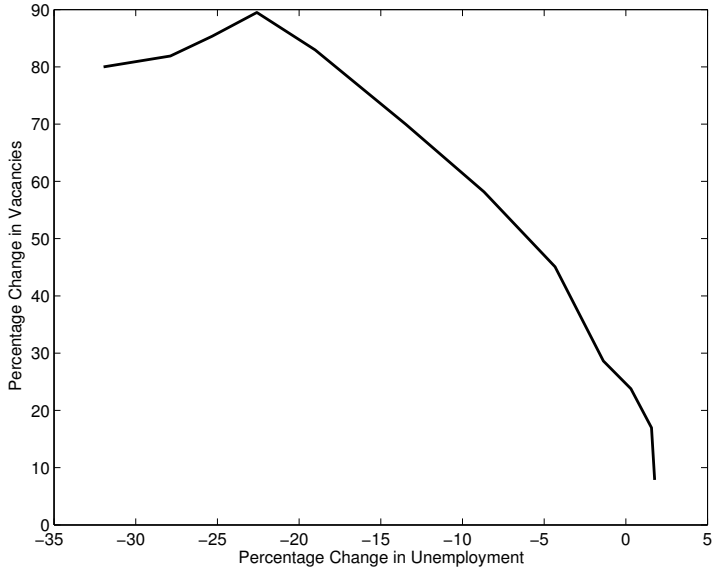

Figure 9: West German Beveridge curve from 2005-2007.

selection. Our simulation shows that the reform also has important equilibrium effects. Our simulation can replicate both the inward shift of the Beveridge Curve after the reform and the larger increase of the job-finding rate for unemployed with longer unemployment durations. Overall, our results suggest that about 50% of the decline in unemployment since 2005 can be attributed to the Hartz IV reforms.

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A Details on the Hartz reforms

In response to rising unemployment in the early 2000s, the Hartz commission, chaired by Peter Hartz,[24] developed recommendations for the German labor market. These proposals were implemented gradually between 2003 (Hartz I and Hartz II) and 2005 (Hartz IV). According to Jacobi and Kuve (2006), the Hartz reforms had three main goals: (1) increasing the effectiveness and efficiency of labor market services, (2) activating the unemployed and (3) boosting labor demand by deregulating labor markets. Under the concept of *"demanding and supporting" (Fordern und Fördern)*, these four reforms radically restructured the German labor market:

Hartz I (in action since 01/01/2003): This reform facilitated the employment of temporary workers. Additionally, vouchers for on-the-job training were introduced.

Hartz II (in action since 01/01/2003): Introduction of new types of marginal employment with low income such as *Minijobs* (up to 450 euros per month, exempted from the income tax) and *Midijobs* (income up to 850 euros per month, reduced social security contributions). Furthermore subsidies for business start ups of unemployed were introduced.

Hartz III (in action since 01/01/2004): The core element of Hartz III was the restructuring of the Federal Employment Agency. The Federal Employment Agency was divided into a headquarter, regional directorates and local job center. Those local job center are now managed via a target agreement. Since Hartz III, all claims of an unemployed person are processed by the same case worker (support from a single source) and an upper limit on the number of cases handled was introduced. Furthermore, a special focus was put on long-term unemployed and unemployed who are older than fifty years. In addition, market elements for private placement services and providers of training measures were introduced.

Hartz IV (in action since 01/01/2005): The last step was the most widely discussed reform since it caused a substantial cut in unemployment benefits for several groups. Unemployment benefits proportional to previous earnings were limited to up to one year, with exceptions for unemployed workers over 45 years old[25] (*Arbeitslosengeld I*). After one year, unemployed shift to the much lower fixed unemployment benefits *Arbeitslosengeld (ALG) II*.[26] Hence, the unemployment assistance[27] and unconditional social assistance was abolished and replaced by *ALG II* which were independent of previous

[24] Peter Hartz was personnel director of Volkswagen at that time.

[25] Since 2009, the maximum duration of ALG I is limited to 12 months for unemployed below 50, to 15 months for people between 50 and 55, 18 months for 55 to 57 and the maximum duration is 24 months for people older than 58 years.

[26] The standard ALG II rate in 2017 is 409 euros.

[27] Unemployment assistance (UA) amounted to 53 % of previous net earnings (57% with children) and was subject to means tests. Hence, other income and assets reduced the claimable amount of UA.

earnings. Eligibility for ALG II depends on savings, life insurance and the partner's income. In addition, a sanctioning system was introduced which allowed cuts in the fixed unemployment benefits if the unemployed person breaks an agreement with the Public Employment Agency (e.g. in terms of writing applications, reachability, responsible economic behaviour).
For a more detailed description of the Hartz reforms, see Jacobi and Kuve (2006) or Launov and Wälde (2016).

B Data

We use annual data on the number of suitable applicants for the most recent hire in the last 12 months and the number of total vacancies of the IAB Job Vacancy Survey. Information on the IAB Job Vacancy Survey can be found in Moczall et al. (2015). Note that since the IAB Job Vacancy survey corresponds to the third quarter of a year, we consistently use third quarter data in our estimations. In addition, data on unemployment and transitions from unemployment into employment (matches) were taken from register data of the federal labour office, the "Integrated Labour Market Biographies (IEB)" (vom Berge et al., 2013).[28] Data for calculating the contact rate for short-term and long-term unemployed stems from the IAB PASS Survey. Furthermore, we take values on the job-finding rates for ALGI (short-term unemployed) and ALGII recipients (long-term unemployed) from (Klinger and Rothe, 2012). They calculated these job-finding rates based on German administrative data. We use the average job-finding rate by duration of unemployment for the time span 1998-2004.[29]

B.1 Details on the IAB Job Vacancy Survey

The Job Vacancy Survey was first carried out in 1989 in West Germany and was extended to East Germany in 1992. It is conducted via a written questionnaire every fourth quarter of the year. Yearly, a stratified random sample of establishments is drawn according to industries, regions as well as size classes. The number of establishments participating ranges from 4,000 in the first years to about 14,000 in the recent years. The data set includes weights to extrapolate the data for the whole economy. Weights for the most recent case of hiring ensure representativeness for all hires.

In 2005, the extrapolation procedure has been revised and adapted backwards until 2000, which causes a break in the data. We control for that by including a shift dummy from the year 2000 onwards (D_{00}) in a robustness check.

[28] Status quo of the data as of January 2016.
[29] This corresponds to the available pre-Hartz period.

We restrict the analysis to West Germany because of the special conditions in East Germany during the transformation period in the 1990s. Furthermore, the question on the number of suitable applicants was not posed in 1990 and gdp growth on detailed state and industry level is available from 1992 onwards. Therefore, we restrict our sample range from 1992 to 2015. Since the aggregate sample range is quite short to conduct time series analysis, we calculate the time series at the federal state and industry level. We aggregate the inverse of the number of suitable applicants by taking mean values. Following Klinger and Rothe (2012, p.17), we add the city state Bremen to the neighboring state Lower Saxony to avoid spatial correlation. The Job Vacancy Survey contains too few observations for small federal states in order to be representative. Therefore, we restrict our sample to federal states with at least 6 million inhabitants.[30]

B.2 Details on the IAB PASS Survey

Furthermore, we use data of the IAB Panel Study Labour Market and Social Security (PASS)[31] to calculate the relative contact rates of long- and short-term unemployed workers. This annual Panel Survey was first carried out in 2007 and consists currently of nine waves. Each wave consists of approximately 10,000 households. Its focus lies on the circumstances and characteristics of recipients of Unemployment Benefit II (ALGII). Interview units are both households as well as individuals (15,000 each year). The Panel consists of two equally large subsamples, (a) recipients of unemployment benefits II (ALGII) and (b) a sample of general German population in which low-income households are overrepresented.[32] In addition, the PASS survey includes several questions on the job search behavior of unemployed workers. These questions regard job search channels, the number of applications as well as the number of job search interviews attended. We measure the contact rate in our model by calculating the share of unemployed workers who attended at least one job interview in the past four weeks. Furthermore, we split unemployed workers by short-term unemployed (ALGI recipients) and long-term unemployed (ALGII recipients). The number of unemployed workers in our sample is 1,806 for ALGI recipients and 23,103 for ALGII recipients. For a detailed description of the IAB PASS survey, see Trappmann et al. (2013).

[30] As of December 2014. Hence, we include Baden-Wuerttemberg, Bavaria, North-Rhine Westphalia, Lower Saxony plus Bremen and Hessen.

[31] Data access was provided via a Scientific Use File supplied by the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

[32] For details, see `http://www.iab.de/en/befragungen/iab-haushaltspanel-pass.aspx`.

C Robustness

C.1 Matching Efficiency Shock

Figure C.1 shows the response of the selection rate to a positive shock to the matching efficiency. A one percent increase of matching efficiency leads to a drop of the selection rate of around 0.1%. Thus, the effect is extremely small and - if any - would bias our results downward.

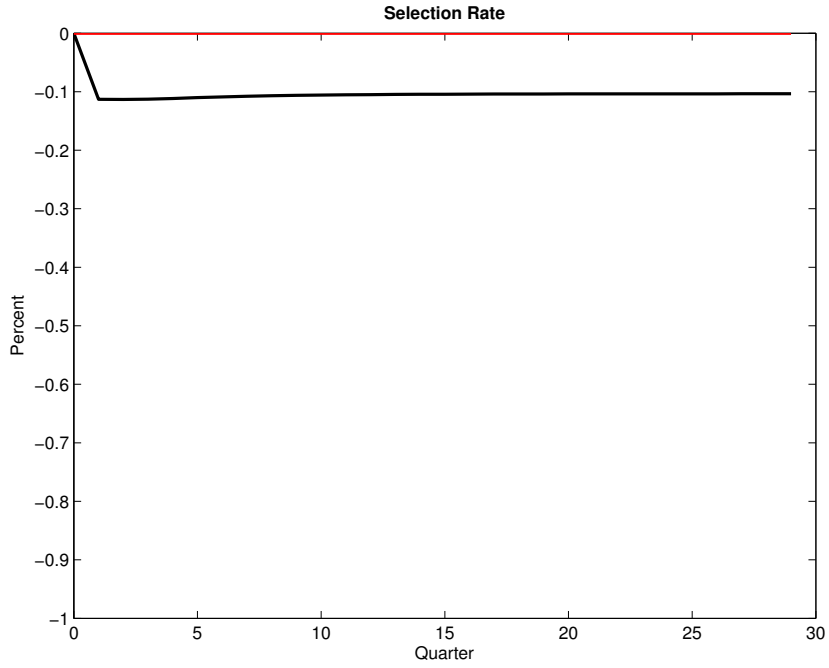

Figure C.1: Response of the selection rate to a 1% positive shock to the matching efficiency.

C.2 Disaggregate Estimation

For robustness, we repeat our estimation on the federal state and industry level. The results are shown in Table C.1. The estimated effects of the Hartz IV reform are very similar.

C.3 Total Number of Applicants vs Applicants per Hire

The first panel in Figure C.2 shows the response of the total number of applicants to the reform in our baseline calibration (defined as the weighted sum of the contact rate multiplied with the number of searching workers for

	Dependent variable:			
	log(selection rate)		log(jfr)	
	State Level	Industry Level	State Level	Industry Level
	(1)	(2)	(3)	(4)
Hartz IV-Dummy	0.10^{***}	0.12^{***}	0.07^{**}	-0.02
	(0.027)	(0.03)	(0.03)	(0.07)
log(market tightness)	0.10^{***}	0.08^{***}	0.23^{***}	0.29^{***}
	(0.01)	(0.02)	(0.02)	(0.06)
Observations	120	192	120	192
R^2	0.22	0.18	0.62	0.39
Adjusted R^2	0.18	0.14	0.60	0.36
F Statistic	16.25^{***} (df = 2; 113)	20.57^{***} (df = 2; 182)	92.16^{***} (df = 2; 113)	58.81^{***} (df = 2; 182)

*Note: Panel Fixed Effects estimation. Standard errors are clustered at group level; *p<0.1; **p<0.05; ***p<0.01*

Table C.1: Regression results for West Germany (1992-2015) on the state and industry level.

every duration group). Due to the equilibrium effect (i.e. a higher contact rate), the number of applicants increases on impact. As unemployment starts to decrease, the number of applicants declines and ultimately falls below its pre-reform level. The second panel shows that the ratio of applicants per hire declines. Note that this is equal to the inverse of the selection rate.

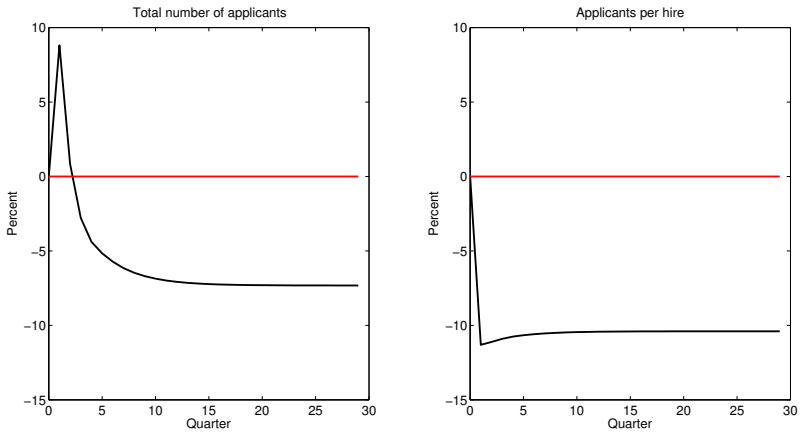

Figure C.2: Response of the total number of applicants and applicants per hire in the baseline calibration.