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

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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 propose a model with different unemployment durations, where the reform initiates both a partial and a general equilibrium effect. The relative importance of these two effects and the size of the partial effect are estimated based on the IAB Job Vacancy Survey. Our indirect inference method provides a solution for the existing disagreement in the macroeconomic literature on Hartz IV. We find that Hartz IV was a major driver for the decline of Germany's unemployment. In addition, we contribute to the literature on microeconomic and macroeconomic effects of unemployment benefit changes.

JEL classification: E24, E00, E60

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PRELIMINARY DRAFT

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.

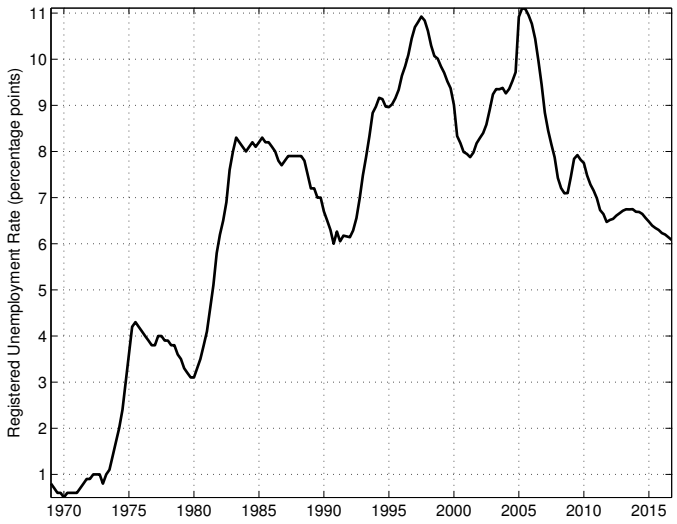

Figure 1: Registered Unemployment Rate in West Germany, 1969-2016. Note that a long time series is only available for West Germany.

While macroeconomic effects of Hartz IV have been studied in the literature before, up to date no clear consensus has emerged on the quantitative importance of the reform on the decline of unemployment. Quite generally, one can distinguish between two approaches in existing studies. The first is to use microeconometric tools to analyze the reform impact on individuals by exploiting differences in their exposure to the reform. Microeconometric estimations can identify what we call the partial effect (PE) of the reform, i.e. the difference in job-finding hazard of a treated versus non-treated individual. An example for this literature is a recent paper by Price (2016). He finds statistically significant and economically meaningful employment effects of the reform. If we believe, however, that the reform further induces general equilibrium (GE) effects, e.g. because it exerts pressure on the general wage level in the economy, macroeconomic tools are needed. Krause and Uhlig (2012), Krebs and Scheffel (2013), Launov and Wälde (2013) all evaluate the reform using simulations of different variants of search (and matching) models of the labor market. However, their results differ substantially and range from a

decline in unemployment of 0.1 percentage points (Launov and Wälde, 2013) to 2.8 percentage points (Krause and Uhlig, 2012). The major reason for these large discrepancies lies in different assumptions about the fall of the replacement rate for long-term unemployed caused by the Hartz IV reform. In practice, it has turned out to be extremely difficult to assign an aggregate value to that variable suited for macro models (see Section 2 for details and a discussion). In fact, estimates of the fall in the replacement rate range from just 7% (Launov and Wälde, 2013) to nearly 70% (upper bound in Krause and Uhlig, 2012).

Against this background, our paper proposes a novel methodology that allows us to distinguish a partial (microeconomic) effect and a general equilibrium (macroeconomic) effect in the model and in the data. Partial and general equilibrium effects are evaluated through the lens of a suitable macroeconomic search and matching model of the labor market. In our model, new 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 benefits for long-term unemployed workers are reduced, this leads to lower wages due to Nash bargaining and thereby initiates two effects. First, firms post more vacancies and the contact rate of all unemployed workers increases. This represents the general equilibrium effect. Second, firms are willing to hire workers with larger idiosyncratic training costs because of lower wages, in particular for those close to or within long-term unemployment. This represents the partial effect in our model.

As it is difficult to measure the average decline of the replacement rate for long-term unemployed, we instead measure the partial response directly based on an outcome variable of our model. More specifically, we construct a time series for the selection rate using the IAB Job Vacancy Survey, which is a representative survey among up to 14,000 firms.[1] To our knowledge, we are the first to i) construct an empirical measure of firms' selection rate (i.e. hiring standards) over time, ii) thereby provide empirical evidence on the importance of the selection margin, and iii) use this to evaluate a labor market reform.

Moreover, we use the time series behavior of the selection rate and the job-finding rate to determine the relative importance of partial and general equilibrium effects over the business cycle. In our model, this pins down the relative size of these two effects in response to unemployment benefit changes. Thus, our paper contributes to the debate on the size of microeconomic and macroeconomic effects of unemployment with respect to benefit changes, which goes far beyond the German case. While there are many papers that estimate the microeconomic effects of different unemployment benefit generosity (see Krueger and Meyer, 2002 for a survey or Card et al., 2015a,b for more recent examples) these may only capture part of the overall effect. This argument is stressed in Hagedorn et al. (2013) who are the first to estimate the macroeconomic elasticity based on policy discontinuities at state borders in the United States. Our empirical approach

[1] In principle, we could also calibrate the partial effect based on Price (2016) in our macroeconomic model. Given that the order of magnitude is similar to our partial effect, we abstain from this exercise.

is completely different and complementary to theirs. To our knowledge, we are the first to construct time series to pin down the partial and general equilibrium effects over the business cycle.

Overall, our calibrated model suggests that the German unemployment rate dropped by 2.6 percentage points due to Hartz IV. Partial and general equilibrium effect each account for roughly half of the initial increase of the job-finding rate.[2] Therefore, aggregate policy statements that are only based on the partial effect would miss an important part of the story.

Compared to the previous macroeconomic literature on the effects of Hartz IV, our results are at the higher end of estimates. Two comments are in order. First of all, both the partial and the general equilibrium effect of our model are soundly anchored in the data. Interestingly, although based on a very different approach to measure the partial effect from the data, our partial effects are very comparable to the estimates found by Price (2016). Second, the shock size needed to generate the targeted partial effect in our model is actually smaller than in Krause and Uhlig (2012) and Krebs and Scheffel (2013). Still, the effect on unemployment is bigger. The reason is that the selection margin provides an additional propagation channel that is usually missing from more standard search and matching models.

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.

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 general equilibrium effects and provides empirical results. Section 5 explains the calibration of the contact function and the selection mechanism. Section 6.1 shows the aggregate partial and general 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 for usually 12 months), long-term unemployed received Arbeitslosenhilfe (53% without children and 57% with children, in principle until retirement). If these transfers were not sufficiently high or if unemployed workers did not have a sufficiently long employment history, they obtained

[2] In the long run, there is an additional effect through a changing unemployment composition, as workers experience on average shorter unemployment duration which increases the average job-finding rate in our model.

the means tested Sozialhilfe. As part of the reform, Arbeitslosenhilfe and Sozialhilfe were merged to Arbeitslosengeld II (ALG II), which is purely means tested.[3] Thus, the system was merged into two pillars. In addition, a second component of Hartz IV, which was implemented in 2006, contained a significant reduction of the maximum duration of "Arbeitslosengeld" for older workers, in particular those above 57. See Figure 2 for an illustration.

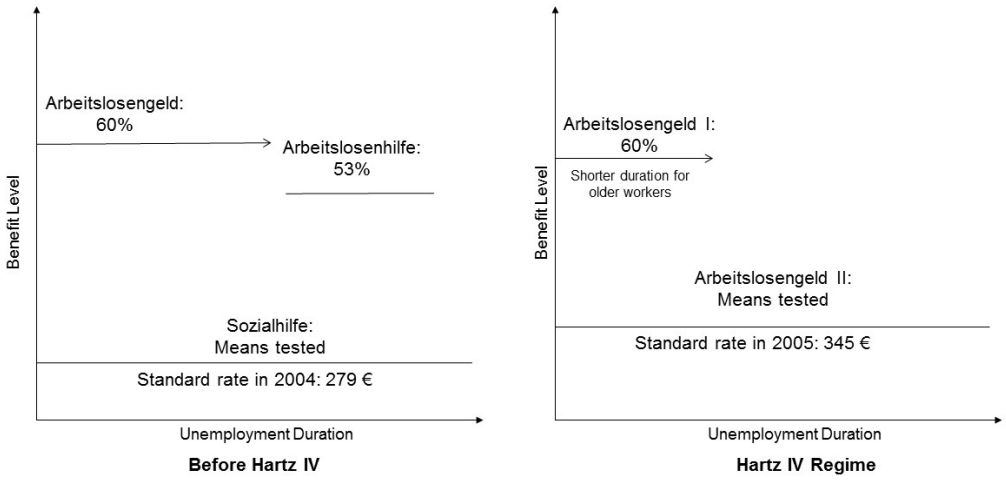

Figure 2: Illustration of the Hartz IV Reform for single households.

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. The latter face a large drop because they may simply be ineligible until they run down their wealth to a certain level.

This institutional setting 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 (without wealth) actually saw a slight increase of their replacement rate. It is very difficult to weigh these groups properly because the low-skill workers are overrepresented in the pool of long-term unemployed and they are affected least by the reform. By

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

contrast, many middle and high income workers may never touch the pool of (long-term) unemployed or may never make a claim for benefits because they would not pass the means testing.[4] However, many aspects of the reform (e.g. switch from proportional to means-tested system) affect 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. In addition, measuring the average decline of the replacement rate is further complicated by the cut in maximum entitlement duration for older workers.

It is therefore not surprising that the key reason for the diverging results in existing macroeconomic studies are different assumptions on the decline of the replacement rate. 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%.

Given the mentioned difficulties in quantifying this drop, we use an outcome variable that is directly affected by a decline of the present value of unemployment (that might be caused both by a decline of the actual replacement rate or cut in entitlement duration), namely the share of workers that is selected by firms.

Except for different unemployment durations, which are essential for the reform, we do not model further heterogeneities in our theoretical framework (e.g. permanent skill differentials or wealth differentials among unemployed workers). The reason is that the IAB Job Vacancy Survey does not provide any guidance in these dimensions. Thereby, the results across groups would be driven by modeling and parametrization choices instead of being disciplined by the data. Thus, we attempt at identifying an average partial and general equilibrium effect in our macroeconomic model.

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

[4] In this case they might not even by counted as unemployed if they do not register with the Federal Employment Agency.

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.[5] This is consistent with the idea that human capital depreciates during unemployment. Only contacts with sufficiently low training costs, $\varepsilon \leq \tilde{\varepsilon}_{it}^d$ will result in a hire, where $\tilde{\varepsilon}_{it}^d$ is firm i's hiring cutoff and $\eta(\tilde{\varepsilon}_{it}^d)$ 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.

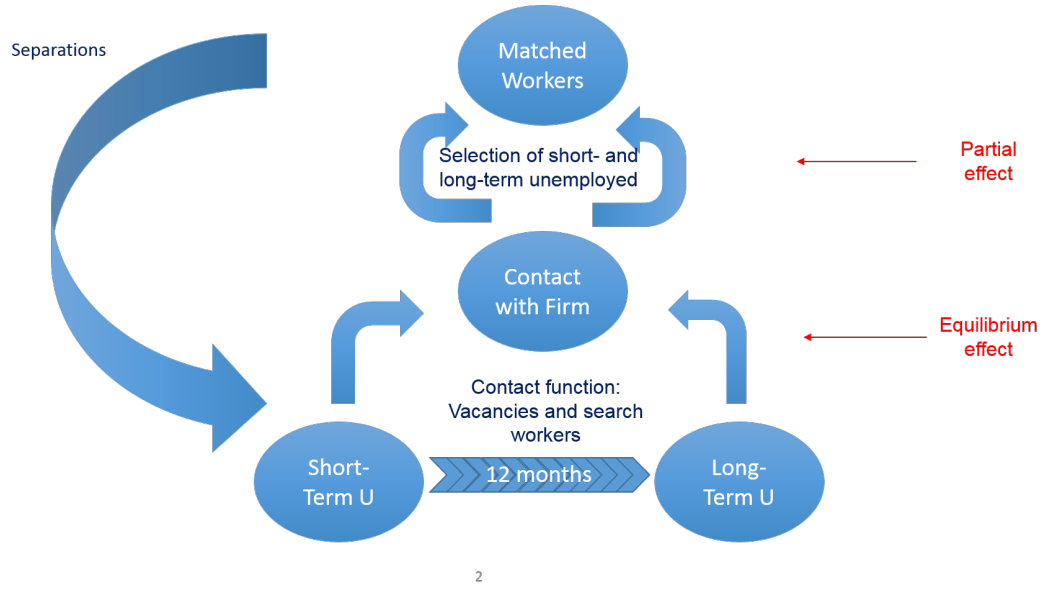

Figure 3: Graphical model description

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 market. The probability for a firm of hiring an unemployed worker indexed by duration d depends on three factors:

[5] 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.

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:

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

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

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

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,

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

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. One of the key differences of our model relative to the standard search and matching model (e.g. Pissarides, 2000) is that matching has two components and that two effects are initiated due to a decline of benefits. First, workers and firms have to get in contact with one another, where p_t denotes the contact rate. Lower unemployment benefits lead to more vacancy posting by all firms (due to higher expected profits). In equilibrium, this leads to a higher contact rate. We call this mechanism the general equilibrium effect. Second, upon contact a certain fraction of workers is selected at the firm level, where η_t denotes the selection rate. With lower unemployment benefits, firms select a larger fraction of applicants who got in contact with them through the contact function. As the wage decreases, firms will hire workers with higher idiosyncratic training costs. Thus, the average number of applicants per hire declines. We call this mechanism the partial effect.

As the aggregate contact and selection rate are roughly multiplicative in our model ($jfr_t \approx p_t \eta_t$),[6] in terms of log-deviations (denoted with hats), we can express the job-finding rate as sum of the contact rate and the selection rate:

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

where $\hat{p}_t$ corresponds to the general equilibrium effect and $\hat{\eta}$ reflects (with a slight abuse of notation) the partial effect.

In the model, both the contact rate p_t and the selection rate η_t increase when long-term unemployment benefits are reduced. Figure 4 shows the impulse response functions (IRFs) of the total number of applicants in the economy and the number of applicants for the last hire.[7] The former is defined as the total number of workers that get in contact with firms. It goes up after the decline of benefits because of an increase of the contact rate due to more vacancies (the general equilibrium effect). In the medium run, it converges to a new steady state which is below the initial level because the pool of unemployed has declined. Very importantly, the number of applicant for the last hire has a completely different dynamics. It is given by the inverse of the selection rate η_t. As an example, when a multi-worker firm selects on average 50% of applicants, it has on average two applicants per hired position. As firms select a larger fraction of applicants due to lower benefits, the number of applicants per hire goes down. Intuitively, if the selection rate was constant, as standard in many search and matching models, the number of matches and the number of contacts in the economy would rise in equal proportion and the number of applicants per hire would not change. But with an increased selection rate, hires increase more than proportionally. This is reflected in a lower number of applicants per hire.

[6] Note that this connection holds with equality for each duration group $jfr_t^d = p_t^d \eta_t^d$. In aggregate, it only holds with equality on impact when the shares of unemployed workers in different duration groups are equal to the steady state shares. During the adjustment dynamics, composition effects start playing a role. See discussion in Section 6.

[7] Note that the IRFs are based on the calibration as described below. At this stage, we show them for illustration purposes and only discuss the qualitative response.

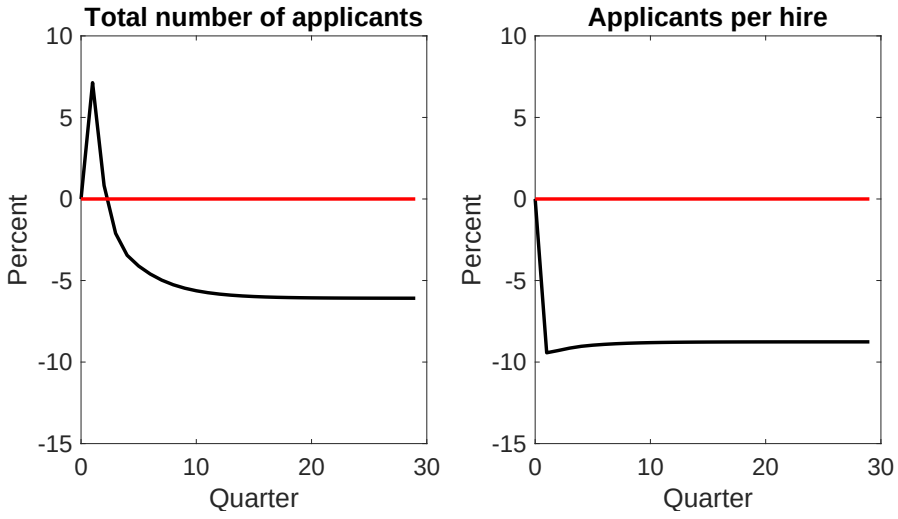

Figure 4: Response of the total number of applicants and applicants per hire in response to a reduction of the replacement rate for long-term unemployed in the baseline calibration.

Based on these insights, 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. Given that firms are asked about the number of *suitable* applicants,[8] 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. Using representative survey weights for the last hire, we construct annual selection rate time series on the national (West Germany), state and industry level.

Figure 5 shows the movement of the job-finding rate, selection rate and market tightness from 1992 to 2015. We normalized all three time series to an average of 1 to improve the visibility of relative movements. As predicted by theory, all three time series are procyclical. 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 over the business cycle in a selection model.

How are these time series helpful for our identification? Ideally, we would be able to identify the reaction of the job-finding rate with respect to benefit changes directly, namely $\partial j\hat{f}r_t/\partial\hat{b}$. Besides the usual econometric issues, this is particularly complicated for the Hartz IV reform. First, several other labor market reforms (namely, Hartz I to

[8] 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.

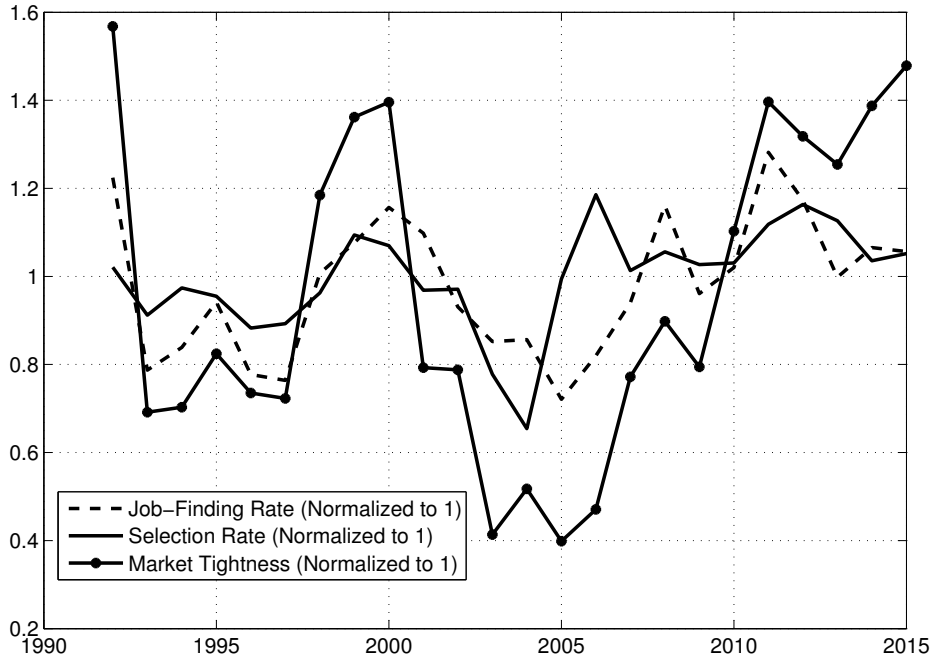

Figure 5: German Labor Market Dynamics, 1992-2015.

III) were implemented in 2003 and 2004, i.e. briefly before the Hartz IV reform. These may have affected the job-finding rate through increases in contact efficiency. Thus, it is very difficult to disentangle the incremental effects of these different reforms based on the job-finding rate. Second, there is a severe structural break in the data in 2005 when unemployment was redefined in Germany. In fact, the definition of unemployment now includes a wider group of people. However, statistically the adjustment to the new definition took place over several months, which makes it very hard to cleanly control for the change in measurement during that time. Therefore, it is impossible to say whether unemployment changes are due to a different definition or actual changes of the unemployment rate. Obviously, this structural break also affects the job-finding rate, which is defined as matches divided by unemployment.

To circumvent this problem, we can decompose the reaction of the job-finding rate to benefit changes as follows:

$$\frac{\partial j\hat{f}r_t}{\partial \hat{b}} \approx \frac{\partial \hat{p}_t}{\partial \hat{b}} + \frac{\partial \hat{\eta}_t}{\partial \hat{b}}. \tag{32}$$

Unfortunately, we cannot provide any estimates for $\partial \hat{p}_t / \partial \hat{b}$ because there is no direct

and independent measure for the contact rate.[9] Therefore, our identification therefore consists of two steps. First, we will directly estimate the partial effect ($\partial\hat{\eta}_t/\partial\hat{b}$) based on our time series of selection.[10] As we will argue in Section 4.2, our measure is neither affected by the structural measurement break nor by changes of the contact efficiency.

Second, we use an indirect inference method to estimate the general equilibrium effect. With an estimate of the partial effect with respect to benefits ($\partial\hat{p}_t/\partial\hat{b}$), all we need to know is how important the response of the contact rate is relatively to the response of the selection rate to a shock. Through the lens of our model, the relative contribution of the contact rate and the selection rate to the transmission of aggregate shocks (in our case, an aggregate productivity shock) and benefit changes is equivalent.[11] We can therefore use the business cycle behavior of the job-finding rate and the selection rate to infer the general equilibrium effect. To be more precise, we will use the following decomposition:

$$\frac{\partial j\hat{f}r_t}{\partial\hat{\theta}_t} \approx \frac{\partial\hat{p}_t}{\partial\hat{\theta}_t} + \frac{\partial\hat{\eta}_t}{\partial\hat{\theta}_t}. \tag{33}$$

The job-finding rate over the business cycle is a function of market tightness and it can be decomposed into the comovement of the contact rate and the selection with respect to market tightness. Thus, in order to identify the relative importance of the partial effect and the general equilibrium effect over the business cycle, we estimate the elasticity of the job-finding rate with respect to market tightness and the elasticity of the selection rate with respect to market tightness.

Note that this is a very different identification strategy compared to the existing literature on the macroeconomic effects of Hartz IV (Krause and Uhlig, 2012; Krebs and Scheffel, 2013; Launov and Wälde, 2013), which 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.

4.1. Identifying Importance of PE and GE

To determine the relative importance of partial effect and the general equilibrium effect, we estimate the elasticity of the job-finding rate and the selection rate[12] with respect to market tightness:

$$\ln Y_t = \beta_0 + \beta_1 D_t^{Hartz\ IV} + \beta_2 \ln\theta_t + \varepsilon_t, \tag{34}$$

[9] If we backed out the contact rate based on the job-finding rate, we would run into the same problems as with the job-finding rate.

[10] Note that $\partial\hat{\eta}/\partial\hat{b}$ in fact contains the pure partial effect - the effect that would also be identified in a causal microeconometric identification - and a small feedback effect on the selection rate through the increase in market tightness. We control for the latter in our estimation.

[11] This can be shown numerically and also analytically in a simplified version of the model. Results are available on request.

[12] Note that we can measure that job-finding rate (based on administrative data) and the selection rate (based on the IAB Job Vacancy Survey). By contrast, the contact rate is not directly observable.

	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.

where the dependent variable is either the logarithm of the job-finding rate or the logarithm of the selection rate. These two dependent variables 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 4.2). 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). In addition,

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 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, the elasticity of the selection rate with respect to market tightness is smaller than the elasticity of the job-finding rate.[13] Thus, the dynamics of the job-

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

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 effect and the general 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 discipline the relative size of the general equilibrium effect.

4.2. Identifying the Partial Effect

Our new time series for the selection rate allows us to estimate the partial effect for the Hartz IV reform. Visual inspection of Figure 5 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. By contrast, 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.[14] In addition, 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 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. Finally, it is worthwhile pointing out that the reform introduced a permanent change in policy. We therefore believe that estimating the reform effect with a simple shift dummy is a valid strategy. Of course, while the selection rate is not immediately affected by changes in tightness (general equilibrium effect), there is a small feedback effect through the influence of contact rates on wages. We therefore condition on the level of tightness in our estimation.[15]

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. In Table C.1 in the Appendix we show that the results are very similar when we use a fixed effects estimator on the state and industry level. In addition, our results are robust to controlling for compositional effects, namely the share of vacancies for low-qualification jobs (see Appendix C.3).

[14] 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.

[15] As the policy change is permanent, effects of future profits are directly reflected in the current level of tightness.

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, while keeping contact rates constant.[16]

The relationship between the change in benefits and the resulting response of the selection rate in our model will to a large extent depend on our assumptions about the distribution of idiosyncratic training costs. Kohlbrecher et al. (2016) show in the context of a similar model structure 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:[17]

$$\frac{\partial \ln \eta}{\partial \ln \theta} = \frac{f\left(\tilde{\varepsilon}\right)}{\eta}\left(\tilde{\varepsilon} - \frac{\int_{-\infty}^{\tilde{\varepsilon}} \varepsilon f\left(\varepsilon\right) d\varepsilon}{\eta}\right). \tag{35}$$

Thus, for a given underlying distributional shape of the idiosyncratic training costs and a given cutoff point,[18] the estimated elasticity of the selection rate with respect to market tightness ($\partial \ln \eta_t / \partial \ln \theta_t$) 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.[19] 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).[20] We target a steady

[16] We could also target the increase of the selection rate in the full model. However, as we condition on tightness in the estimation, we do the same in our calibration. In addition, the feedback effect lowers the response of the selection rate. We therefore choose the more conservative strategy.

[17] 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.

[18] 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.

[19] 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.

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

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 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.

Using the data provided by 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.[21] 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,[22] our calibration implies that the fixed training

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

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

costs component increases every month with the duration of unemployment.[23]

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 the selection rate with respect to market tightness, which is 0.15 in our data. The resulting scale parameter of the distribution is 3.8.[24] 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

This section proceeds in three steps. First, we show the partial effects in our model. Although we target the aggregate PE in our estimation, we can make statements on the response of the selection rate for each unemployment duration group. Second, we switch on general equilibrium effects and analyze how aggregate unemployment and vacancies changed due to Hartz IV. Third, we put our quantitative results in perspective to other papers on the German Hartz reforms.

6.1. Partial Effects

Our empirical estimation in Section 4 has shown that the reform resulted in a 13% increase in the selection rate (controlling for aggregate market tightness). We therefore target the same increase of the average selection rate in the quantitative model, while keeping general equilibrium effects switched off (i.e. a constant contact rate).

For this purpose, we require a decline of unemployment benefits for long-term unemployed of 11.3%. This is a value within the range used by Launov and Wälde (2013), Krause and Uhlig (2012), and Krebs and Scheffel (2013).

Figure 6 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 due to a lower outside option. However, the effect is larger, the closer the unemployed get to the expiration of the more generous short-term benefits. For workers who have

[23] 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.

[24] 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.

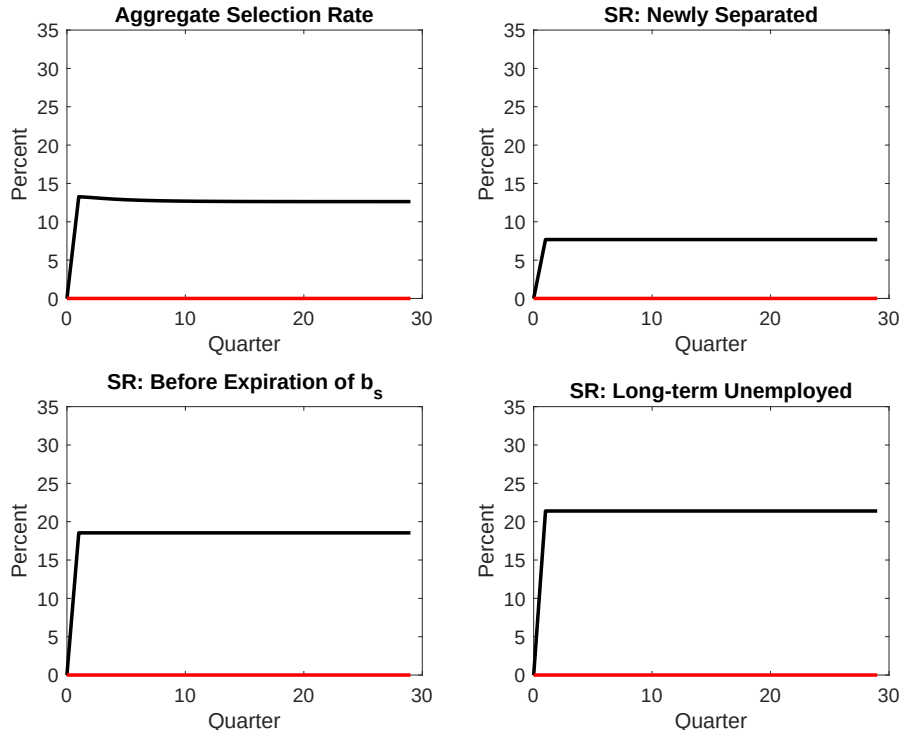

Figure 6: Selection rate (SR): impulse responses to a 11.3% decline in long-term unemployment benefits.

just been separated from a job (upper right panel in Figure 6), 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 8%. 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 19%. This is in line with (Price, 2016) who finds that unemployed workers reservation wages and job-finding rates increase sharply before the expiration of benefits. 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 21%.[25] Figure 7 shows the impact responses of the selection rate in response to a decline in long-term unemployment benefits for all duration groups of our model. The x-axis indicates the time remaining until short-term benefits expire. We see that the response increases gradually with the expiration of short-term benefits coming nearer

[25] 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).

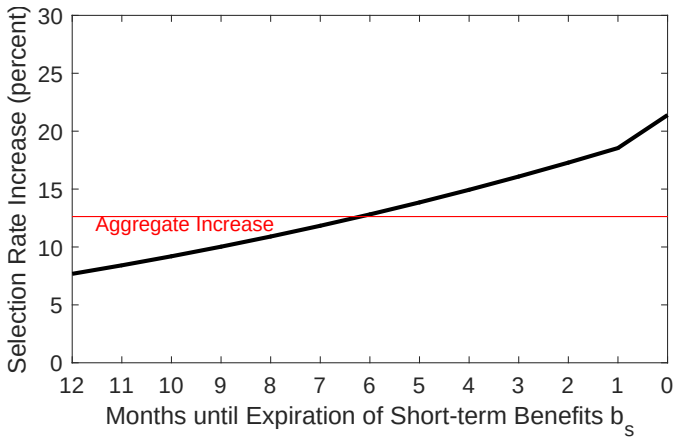

Figure 7: Impact responses of selection rate to a decline of long-term unemployment benefits by remaining months of short-term benefit entitlement.

and kinks at the expiration threshold.

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 months of beginning a claim increases by 4 percentage points for men and 5.8 percentage points for women. We find an increase of the reemployment 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.[26] 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 reassuring, 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).

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

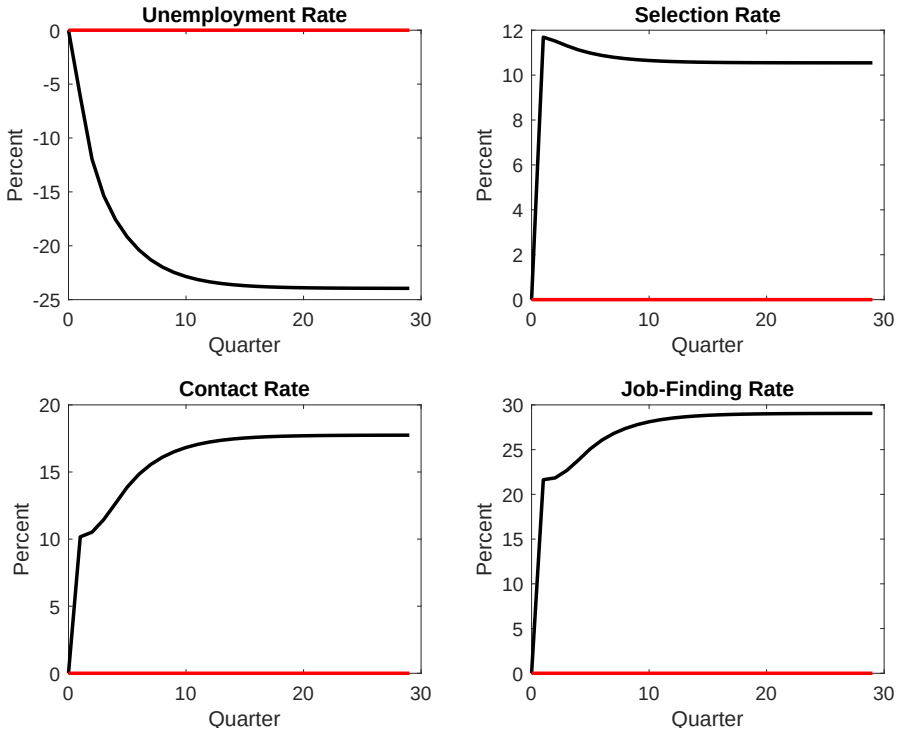

Figure 8: Impulse responses to a decline in long-term unemployment benefits.

6.2. General Equilibrium Effects

Our approach allows us to quantify the general equilibrium effect. Keep in mind that we have disciplined the relative magnitude by our estimations in Section 4. 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 8. The contact rate for unemployed workers rises by 10% on impact.[27] The overall job-finding rate, which is the product of both the contact and the selection rates, increases by 22% on impact (lower right panel of Figure 8). Therefore, about half of the initial response of the job-finding rate is due to the general equilibrium effect.

Note that the response of the selection rate (12% increase on impact, 11% higher in the new steady state), is a bit smaller in the full model compared to the model with the general equilibrium effect switched off. The reason is a small negative feedback effect from increased contact rates on the wage level and hence the selection rate.

Overall, the unemployment rate falls by 24%. This corresponds to a decrease of the unemployment rate by 2.6 percentage points in our calibration. Hence, the Hartz IV reform can account for more than 40 percent of the decline in German unemployment.

[27] 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.

When the economy adjusts to a new steady state, the composition of the pool of unemployed changes. This can be seen in the adjustment dynamics of the contact and job-finding rate, which increase quite sluggishly.[28] The aggregate contact and job-finding rates are a weighted average for all duration groups. Due to the reform, the duration of unemployment is shortened. The share of the searching workers with long unemployment duration declines over time. The share of long-term unemployed, who have much lower contact rates, is 10 percentage points lower in the new steady state.[29] When we control for the composition effect,[30] the unemployment rate falls by 19% or 2.1 percentage points (instead of 2.6 percentage points). The increase of the selection rate (partial effect) and the contact rate (general equilibrium effect) each account for roughly half of this decline when controlling for composition.

Finally, it is interesting to study the trajectory of the Beveridge curve in the data and in the model. Figure 9 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 10). Similar to the simulation, vacancies increase, overshoot somewhat and end up at a higher level.[31] 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.

6.3. Broader Perspective

How do our results compare to changes of labor market stocks and flows around the time of the Hartz reforms? Although the labor market data is somewhat difficult to interpret due to a major structural break of the unemployment definition in 2005 (and thereby also the job-finding rate), a comparison to recent empirical studies delivers interesting patterns.

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

[29] In principle, the composition effect could also be driven by selection. However, in our calibration, most of the differences in job-finding rates between long- and short-term unemployed are accounted for by lower contact efficiencies, which was guided by the PASS survey.

[30] We assume counterfactually that the shares of in each unemployment duration group stays constant

[31] 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).

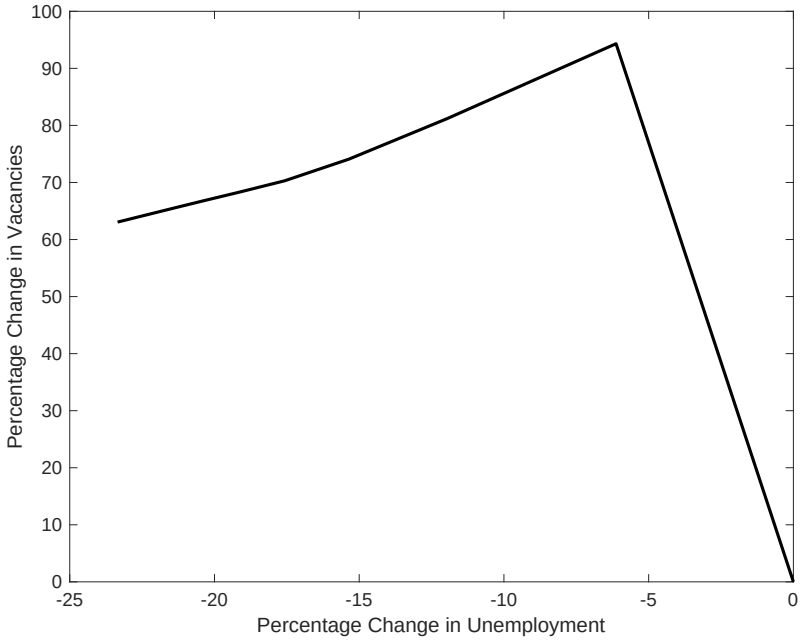

Figure 9: Beveridge curve generated by the model during first three years after the shock.

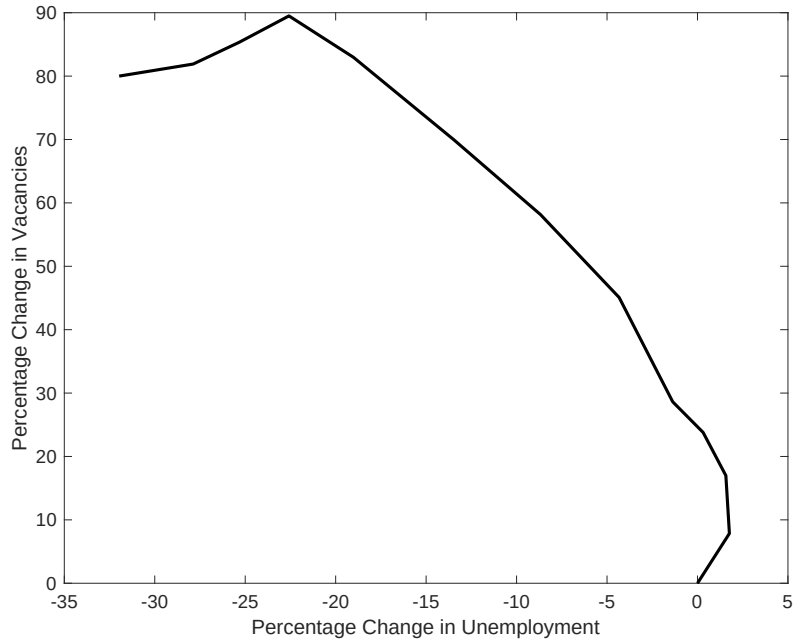

Figure 10: West German Beveridge curve from 2005-2007.

In recent papers, Carrillo-Tudela et al. (2018) and Rothe and Wälde (2017) document that more people transitioned from unemployment into non-standard forms of employment or training programs around the time of the Hartz reforms. Non-standard employment or active labor market policies may have served as a stepping stone into regular jobs. In fact, based on a pure descriptive basis, using the data provided by Klinger and Rothe (2012), we find that total outflow rates from short-term and long-term unemployment (in contrast to direct transitions into regular employment) indeed increased by 26% and 20% between 2005 and mid 2009.[32]

Interestingly, Price (2016), whose estimated causal effects are comparable to our partial effects, documents that most unemployed workers that were affected by the reforms transitioned into full-time employment.

Against the background of Price's (2016) results and the findings by Carrillo-Tudela et al. (2018) and Rothe and Wälde (2017) on labor market transitions around the time of the German Hartz reforms, it may be the case the the general equilibrium effect was transmitted in a more complex and sluggish way than in our simulated model (e.g. via irregular types of unemployment, which served as stepping stones). To the extent that stepping stones played an important role, our model overestimates the speed at which the general equilibrium effect generates full-time jobs. To our knowledge, there exists no macroeconomic labor market framework which allows modeling stepping stone effects. In addition, given that many reforms and redefinitions have taken place in between 2003 and 2005, it is very difficult to link the descriptives to a particular reform.

The key lesson is that the adjustment dynamics of our general equilibrium effect with respect to full-time employment has to be interpreted with caution. In reality, there are various adjustment channels to labor market reforms (e.g. the willingness to accept atypical jobs), while we only have the wage effect in the model. However, the dynamics of the partial effect appears to be completely in line with the data (Price, 2016). In addition, our paper has offered a new methodology how to appropriately identify the importance of the partial effect versus the general equilibrium effect in the medium to long-run when adjustment dynamics play less of a role.

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 existing literature, our identification strategy does not hinge on an external source for the quantitative 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 IAB Job Vacancy Survey and show that their selection rates increased following the Hartz IV reform. In addition, we estimate the relative importance of partial and general equilibrium effects over the business cycle and impose it on our model. Our simulation shows

[32] Interestingly, flows to non-participation appear to have played no major role. While these were rising with the previous Hartz reforms, flows from unemployment to non-participation actually declined after 2005 (compare Carrillo-Tudela et al., 2018).

that the reform had important general equilibrium effects. Our simulated model can match important macroeconomic and microeconomic facts, such as 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 show that 2.6 percentage points of the decline in unemployment since 2005 can be attributed to the Hartz IV reforms.

References

Card, D., A. Johnston, P. Leung, A. Mas, and Z. Pei (2015a): "The Effect of Unemployment Benefits on the Duration of Unemployment Insurance Receipt: New Evidence from a Regression Kink Design in Missouri, 2003-2013," *American Economic Review*, 105, 126–130.

Card, D., D. S. Lee, Z. Pei, and A. Weber (2015b): "Inference on Causal Effects in a Generalized Regression Kink Design," *Econometrica*, 83, 2453–2483.

Carrillo-Tudela, C., A. Lanov, and J.-M. Robin (2018): "Work-Sharing and the Fall of Unemployment in Germany," Mimeo.

Chugh, S. and C. Merkl (2016): "Efficiency and Labor-Market Dynamics in a Model of Labor Selection," *International Economic Review*, 57, 1371–1404.

Hagedorn, M., F. Karahan, I. Manovskii, and K. Mitman (2013): "Unemployment Benefits and Unemployment in the Great Recession: The Role of Macro Effects," NBER Working Papers 19499, National Bureau of Economic Research, updated version 2016.

Jacobi, L. and J. Kuve (2006): "Before and After the Hartz Reforms: The Performance of Active Labour Market Policy in Germany," Tech. rep., IZA Discussion Paper No. 2100.

Klinger, S. and T. Rothe (2012): "The Impact of Labour Market Reforms and Economic Performance on the Matching of the Short-term and the Long-term Unemployed," *Scottish Journal of Political Economy*, 59, 90–114.

Kohlbrecher, B., C. Merkl, and D. Nordmeier (2016): "Revisiting the Matching Function," *Journal of Economic Dynamics and Control*, 69, 350–374.

Krause, M. and T. Lubik (2007): "The (ir)relevance of real wage rigidity in the New Keynesian model with search frictions," *Journal of Monetary Economics*, 54, 706–727.

Krause, M. and H. Uhlig (2012): "Transitions in the German labor market: Structure and crisis," *Journal of Monetary Economics*, 59, 64–79.

Krebs, T. and M. Scheffel (2013): "Macroeconomic Evaluation of Labor Market Reform in Germany," *IMF Economic Review*, 61, 664–701.

Krueger, A. B. and B. D. Meyer (2002): "Labor Supply Effects of Social Insurance," Elsevier, vol. 4 of *Handbook of Public Economics*, chap. 33, 2327–2392, 1 ed.

Launov, A. and K. Wälde (2013): "Estimating Incentive and Welfare Effects of Nonstationary Unemployment Benefits." *International Economic Review*, 54, 1159–1198.

——— (2016): "The employment effect of reforming a public employment agency," *European Economic Review*, 84, 140–164.

Moczall, A., M. Anne, M. Rebien, and K. Vogler-Ludwig (2015): "The IAB Job Vacancy Survey. Establishment Survey On Job Vacancies and Recruitment Processes. Waves 2000 to 2013 and subsequent Quarters from 2006." Tech. rep., Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

Pissarides, C. A. (2000): *Equilibrium Unemployment Theory, 2nd Edition*, vol. 1 of *MIT Press Books*, The MIT Press.

Price, B. (2016): "The Duration and Wage Effects of Long-Term Unemployment Benefits: Evidence from Germany's Hartz IV Reform," MIT Department of Economics, mimeo.

Rothe, T. and K. Wälde (2017): "Where Did All the Unemployed Go? Non-standard work in Germany after the Hartz reforms," Discussion Paper 1709, Gutenberg School of Management and Economics & Research Unit "Interdisciplinary Public Policy".

Schmieder, J. F., T. von Wachter, and S. Bender (2016): "The Effect of Unemployment Benefits and Nonemployment Durations on Wages," *American Economic Review*, 106, 739–77.

Sedláček, P. (2014): "Match Efficiency and Firms' Hiring Standards," *Journal of Monetary Economics*, 62, 123–133.

Seeleib-Kaiser, M. (2016): "The End of the Conservative German Welfare State Model," *Social Policy and Administration*, 50, 219–240.

Trappmann, M., J. Beste, A. Bethmann, and G. MÃ¼ller (2013): "The PASS panel survey after six waves." *Journal for Labour Market Research*, 46, 275–281.

vom Berge, P., A. Burghardt, and S. Trenkle (2013): "Sample of Integrated Labour Market Biographies - Regional file 1975-2010 (SIAB-R 7510)," FDZ-Datenreport, 09/2013, Nuremberg.

A. Details on the Hartz reforms

In response to rising unemployment in the early 2000s, the Hartz commission, chaired by Peter Hartz,[33] 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 (*Arbeitslosengeld I*).[34] After one year, unemployed shift to the much lower fixed unemployment benefits *Arbeitslosengeld (ALG) II*.[35] Hence, the unemployment assistance[36] and social assistance was abolished and replaced by *ALG II* which is independent of previous earnings. Eligibility for ALG II depends on savings 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).

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

[34] 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.

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

[36] 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.

In addition, the Hartz IV law also includes a reduction of the maximum entitlement duration of short-term unemployment benefits for workers older than 45 years by up to 14 months. This reform step became effective on February 1, 2006.

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).[37] 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.[38]

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.

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.

[37] Status quo of the data as of January 2016.

[38] This corresponds to the available pre-Hartz period.

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.[39]

B.2. Details on the IAB PASS Survey

Furthermore, we use data of the IAB Panel Study Labour Market and Social Security (PASS)[40] 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.[41] 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).

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.

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.

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

[40] 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).

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

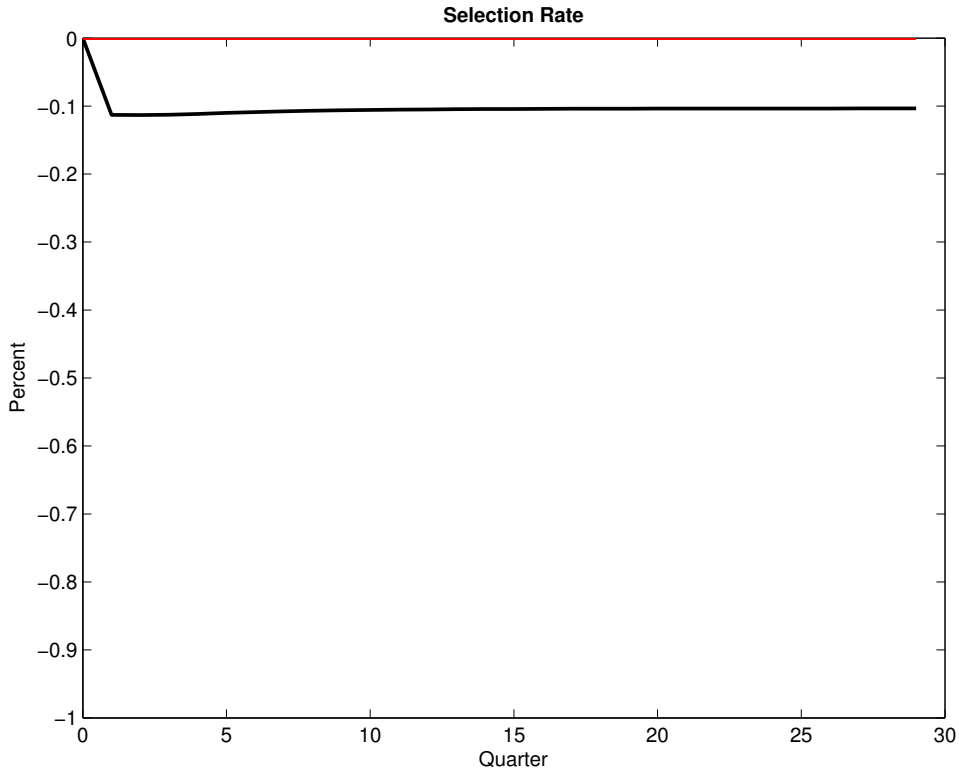

Figure C.1: Response of the selection rate to a 1% positive shock to the matching efficiency.

	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.

C.3. Controlling for skill composition

We repeat the estimation for the selection rate, while controlling for the share of vacancies for jobs with a low-qualification profile. It principle, it could be the case that such jobs are associated with very different selection rates (compared to jobs demanding higher qualification) and that these composition effects drive our estimation results. However, the results in Table C.2 show that our baseline results are robust to this modification.

Table C.2: Control for the share of low-qualification vacancies

	Dependent variable:	
	log(selection_rate)	
	Baseline	low qualification
Hartz IV-Dummy	0.13***	0.17***
	(0.04)	(0.03)
log(market_tightness)	0.15***	0.11**
	(0.05)	(0.04)
log(low_qualification)		0.40***
		(0.11)
Constant	−0.56***	0.18
	(0.09)	(0.22)
		Observations
Observations	24	24
R^2	0.544	0.716
Adjusted R^2	0.500	0.674
Residual Std. Error	0.091 (df = 21)	0.074 (df = 20)
F Statistic	12.502*** (df = 2; 21)	16.828*** (df = 3; 20)
Note:		*p<0.1; **p<0.05; ***p<0.01