The Employment Effect of Reforming a Public Employment Agency

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How much does an increase in operating effectiveness of a public employment agency (PEA) and a reduction of unemployment benefits reduce unemployment? Using a recent labour market reform in Germany as background, we find that an enhanced effectiveness of the PEA explains about 20% of the observed post-reform unemployment decline. The role of unemployment benefit reduction explains just about 5% of the observed decline. Due to disincentive effects resulting from the reform, the reform of the PEA could have had an even higher impact on unemployment reduction if there had been less focus on long-term unemployed workers.

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1 Introduction

Understanding the determinants of unemployment has always been at the center of economic research and public interest alike. This is true in "old times" when oil price shocks hit OECD countries, just as much as today in the aftermath of the financial crisis.

It is widely accepted by now that labour market institutions such as the unemployment benefit system, trade unions, minimum wages, employment protection legislation and labour taxes stand among key determinants of unemployment in OECD countries (see e.g. Blau and Kahn, 1999, and Nickell and Layard, 1999). Despite their apparent heterogeneity, all these institutions have one salient trait in common: whatever the degree of coordination frictions, they shape the incentives of the market participants. Just in contrast to that stands another important labour market institution: the public employment agency. Whatever the incentives of the market participants, public employment agencies reduce the degree of coordination frictions (Petrongolo and Pissarides, 2001).

While employment effects of unemployment benefits, unions, employment protection and taxation have been quite extensively studied to this date, there is surprisingly little evidence on the role of a public employment agency (PEA) in reducing equilibrium unemployment. The present paper fills this gap.

We use the unique setup of a comprehensive labour market reform introduced between 2003 and 2005 in Germany. This reform induced an increase in operating effectiveness of the Federal Employment Agency (a PEA) and reduced the generosity of payments to the unemployed.[2] We structurally estimate the effect of the increase of operating effectiveness on the equilibrium unemployment rate. We then compare this impact with the impact of the reduction of unemployment assistance benefits. We find that organizing the work of a PEA in a more efficient way has scored a much better result than creating pecuniary incentives through unemployment assistance benefits. Quantitatively, the re-organization of the agency is responsible for a 0.69 to 0.88 percentage point drop of the equilibrium unemployment rate, explaining 17.7% to 22.5% of the observed post-reform decline in unemployment. Benefit reduction, in contrast, adds only 0.18 to 0.20 percentage points to the fall of the equilibrium unemployment rate. This explains merely 4.6% to 5.1% of the observed post-reform unemployment decline.

Furthermore, and somewhat surprisingly, we find an "unemployment paradox": An increase in effectiveness of a PEA can lead to an *increase* of the unemployment rate. An ambiguous response of the unemployment rate to the reform can arise, for instance, if the reform design favours long-term unemployed workers more than short-term ones. When a PEA becomes more effective in matching the long-term unemployed, search effort and hence exit rates of long-term unemployed workers go up. Short-term unemployed workers anticipate this increase in the exit rate and therefore have less incentives to search intensively while still being short-term unemployed. Consequently, search effort and exit rates of the short-term unemployed go down. As long as the disincentive effect on the short-term unemployed workers is stronger than the positive influence on the long-term unemployed workers, the unemployment rate *rises* when the PEA becomes more productive.

[2] We use the term effectiveness to denote total factor productivity of the matching function. This differs from individual search productivity which is a paramter in an individuals' arrival rate. See our specification below for details.

Quantitatively, we indeed find that the reform's focus on long-term unemployed workers weakened the overall intended goal. If the increase in matching effectiveness of the agency for the long-term unemployed workers had been just as high as the (smaller) increase in effectiveness for the short-term unemployed, the reform would have reduced the equilibrium unemployment rate by further 0.21 percentage points. Apparently, the extra increase of matching efficiency for the long-term unemployed workers was too much of a good thing.

To reach our conclusions we build on the nonstationary search and matching model of Launov and Wälde (2013). We extend this model to allow for a matching effectiveness of the public employment agency that changes due to a reform and that varies with duration of unemployment. Our model shares a number of elements with the existing search and matching literature. Workers are ex-ante heterogeneous in skills, as in Mortensen and Pissarides (1999) and Postel-Vinay and Robin (2002), and ex-post heterogeneous in duration of their unemployment spells. The model allows for time-dependent unemployment benefits, as in Albrecht and Vroman (2005) and Coles and Masters (2006), to capture the differences between unemployment insurance (UI) and unemployment assistance (UA) payments. Benefits are proportional to past wages, as in Chéron and Langot (2010), and there is a fixed time limit on UI. Workers optimally choose search effort, as in Cahuc and Lehmann (2000) and Lehmann and van der Linden (2007), and experience negative duration dependence of their exit rates out of unemployment due to Bayesian learning. The simultaneous presence of a duration-contingent effectiveness of the PEA and time-dependent unemployment benefits in our model allows for an easy comparison of the equilibrium effects of the reforms of these two institutions.

To quantify the employment effect of the reform of the PEA in Germany we estimate our theoretical model using the following two-stage procedure. At the first stage we estimate all parameters of the pre-reform steady state from the pre-reform data, keeping matching effectiveness parameters of the agency for short- and long-term unemployed workers normalized to unity. Estimation at the first stage is fully structural, by maximum likelihood, as e.g. in Ridder and van de Berg (1998). The data are the survey data on individual employment histories taken from the German Socio-Economic Panel. At the second stage we use both pre-reform and post-reform data to estimate the reform-induced increase of the matching effectiveness of PEA for short- and long-term unemployed, taking the estimates from the first stage as given. Estimation at the second stage is again fully structural, using indirect inference as e.g. in Lise (2013) and Bagger et al. (2014). The data are the regional time series data on matches, vacancies and unemployment collected by the Institute for Employment Research (IAB, Nürnberg). Auxiliary regressions at the second step match the impact coefficient of the reform of the PEA on log-matches for short- and long-term unemployed workers.[3] The entire two-step approach is similar to the one of Postel-Vinay and Turon (2010). Estimated increases of the effectiveness of the agency due to the reform of the PEA immediately lead to the change in equilibrium unemployment caused by this reform.

To the best of our knowledge, our paper is the first to estimate the equilibrium employment effect of a reform of a PEA. The closest papers to ours in the structural literature on employment agencies are Pissarides (1979) and Fougère et al. (2009). Pissarides (1979) considers a theoretical equilibrium search model in which unemployed workers can obtain

[3]Fahr and Sunde (2009) and Klinger and Rothe (2012) use similar regressions to assess the reform.

job offers either via a PEA, or via a PEA and through private search. Both search channels are costly to workers and a match via a PEA is costly to firms. Pissarides (1979) shows that his model displays what could be called a "public-private unemployment paradox": An improvement of the matching technology of the PEA can *increase* the aggregate unemployment rate. Fougère et al. (2009) set up a one-sided empirical job search model to evaluate the optimal private search effort when the PEA provides job offers at an exogenous rate and when private search is costly. Their model likewise implies a public-private unemployment paradox. Estimating their model with French data, however, they find that a more productive PEA clearly increases exit from unemployment.

Even though our model does not include private search, we still obtain an unemployment paradox. Ours is intertemporal in nature, being a consequence of the heterogenous change of the agency's matching effectiveness for long-term and short-term unemployed workers and the anticipation by the short-term unemployed workers. Going beyond these two papers, we also evaluate the impact of a real-life reform of a PEA and emphasize the importance of an improved PEA relative to changes in unemployment benefits.[4]

Other papers related to our analysis include Jung and Kuhn (2013) and Krebs and Scheffel (2014). Jung and Kuhn (2013) show that low effectiveness of a PEA in matching unemployed with vacant jobs is largely responsible for the difference in "ins" and "outs" of unemployment between Germany and the US in the 1980s and 90s. Krebs and Scheffel (2014) argue that an increased effectiveness of a PEA reduces the cost of recessions.[5]

Our paper also contributes to two further strands of the literature that deal with labour market policies and institutions. First, we add to the structural literature which quantifies the employment effect of institutions. To give a few recent examples of this literature, Yashiv (2004) and Pries and Rogerson (2005) simulate the individual and joint impact of a wide array of institutions, such as unemployment insurance, hiring subsidy, labour taxes and minimum wages. Cahuc and Malherbet (2004) calibrate the employment effect of an experience-rated system of financing unemployment benefits. Immervoll et al. (2007) perform microsimulations on the influence of in-work benefits and L'Haridon and Malherbet (2009) look into the effect of employment protection through layoff tax and payroll subsidy. Boeri and Burda (2009) investigate the impact of endogenous coverage of collective bargaining and Bentolila et al. (2012) assess the role of temporary contracts and firing costs. Finally, Flinn (2006) sets up structural estimation of the employment effect of a minimum wage and Launov and Wälde (2013) do the same for the length and level of unemployment benefits. We contribute to this literature by evaluating - as we show - a very important institution which, surprisingly, has been largely overlooked so far. This institution is the PEA itself.

Second, we add to the existing reduced-form econometric literature on the effectiveness of PEAs as compared to other search methods. This literature predominantly follows the pioneering contributions of Holzer (1988) and Blau and Robins (1990), considering a multitude of job search techniques used by unemployed workers.[6] Conclusions on the effectiveness of the agency in this literature vary. Yet, irrespective of the conclusions, its reduced-form

[4] Future work should allow both for the public-private channel and for the intertemporal channel.

[5] More distantly related articles comprise Plesca (2010), who sets up a model with directed search through agencies, and Yavaş (1994), who views agencies as middlemen.

[6] See Weber and Mahringer (2008) for a recent application and summary of this literature over the preceding twenty years.

nature makes it hard to infer about the effect of the PEA on the equilibrium unemployment rate. We contribute to this literature by looking beyond the simple significance of the agency and estimate its equilibrium impact on the dynamics of unemployment.

The paper is organized as follows. Section 2 presents stylized facts about German unemployment and provides a detailed description of the comprehensive labour market reform of 2003-2005 (the so-called Hartz reform). Section 3 describes the theoretical model we use to reach all of our conclusions. It also works out the ambiguity of the impact of the reform of a PEA under heterogeneous increase of matching effectiveness for short- and long-term unemployed workers. Section 4 lays out the structural estimation procedure, discusses the estimation results and analyses the effect of an improvement of a PEA relative to a reduction of unemployment benefits. Section 5 concludes.

2 Labour market reforms in Germany

2.1 Stylized facts

Like many large continental European countries, Germany has been experiencing a steady increase in unemployment ever since the early 1970s. As Figure 1 shows, this rise continued in Germany until early 2005.[7]

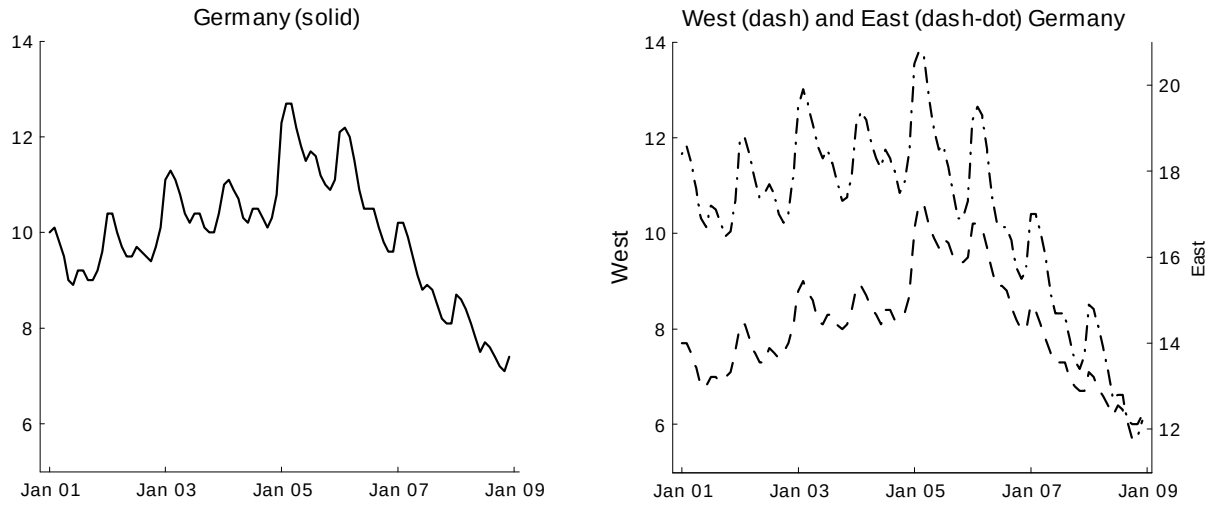

Figure 1 *Monthly unemployment rate around the time of the Hartz reforms (data source: Bundesagentur für Arbeit)*

The absence of any persistent reversal by the 2000s called for a restructuring of the (supposedly) generous institutions of the welfare state. The long awaited political response

[7]The increase leading to the peak in January 2005 is higher than in other years. This is related to a structural break in unemployment statistics, as from January 2005 onwards all former recipients of welfare payments had to register as being unemployed in order to be eligible to benefit payments.

has arrived with a comprehensive labour market reform: the *Hartz reform*. The reform has been introduced step by step between 2003 and 2005. It consisted of four different packages (Hartz I to IV) which affected nearly all aspects of the German labour market. It is remarkable that its third package (Hartz III) was almost exclusively devoted to reorganizing the operation of the Federal Employment Agency, while its last package (Hartz IV) focused almost exclusively on the monetary compensation scheme for the unemployed workers.

As of March 2005, a strong decline in unemployment has set in. This applies both to Germany as a whole (left panel of Figure 1) and to East and West Germany separately (right panel). In terms of numbers, between the introduction of Hartz IV and the onset of the Great Recession, the unemployment rate in Germany has gone down from 11.7% in 2005 to 7.8% in 2008, i.e. by 3.9 percentage points. The same applies to East and West Germany with 5.6 and 3.5 percentage points reduction, respectively.

2.2 Institutional framework of the reform

The Hartz reform has been designed to substantially refurbish the institutional organization of the German labour market, affecting nearly all of its facets.

To give a clear idea of what is the place of the two institutions of our interest, namely the PEA and unemployment benefits, in the entire set of policy measures introduced, we provide a brief overview of all core packages of the Hartz reform (for details on the corresponding literature, see Appendix A.1).

Hartz I has launched a considerable variety of employment-stimulating programmes and flexible forms of work. It has also established personnel service agencies which serve as intermediaries between job searchers and employers offering temporary (subcontracted) work placement. It has furthermore introduced training vouchers to take advantage of occupational training and implemented special rules for job market integration of workers over 50 years of age. On top of that, Hartz I has strengthened sanctions in case of voluntary job quits, rejection of suitable offers and aborting training programs or temporary work placement. This package has become effective as of January 2003.

Hartz II has re-organized marginal employment represented by so-called "mini-" and "midijobs". Workers in minijobs were allowed to earn up to EUR 400 tax-free per month. A linear tax rule was introduced for midijobs paying up to EUR 800 per month. Hartz II has also modified the program for start-up subsidies to enhance transitions to self-employment. It became effective simultaneously with Hartz I.

Hartz III has laid out the internal administrative reform of the Federal Employment Agency as an entity. It has brought in a set of new regulations and revised the distribution of responsibilities within the agency. Most importantly, all claims by an unemployed worker have now become processed by a single case-worker. Further, limits on the number of cases supervised by a single case-worker were introduced. Along with importance grading of cases, this has allowed to increase contact time per unemployed worker. Another important feature of this package was the provision of separate advice for short- and long-term unemployed workers. Hartz III has also reduced the weight of active labour market programs. It has become effective as of January 2004.

Hartz IV has abolished the proportionality of the former UA benefits to previous net earnings. Fixed UA benefits (called *Arbeitslosengeld II*; ALG II) were introduced instead, low

enough to generate a reduction of assistance payments on average. Hartz IV has furthermore reduced the duration of entitlement to UI benefits (now called *Arbeitslosengeld I*; ALG I) for workers over 45. Severity of this reduction of entitlement duration increased with age. This package has become effective as of January 2005.

This overview shows why looking at the Hartz reform is rewarding if one wants to estimate the effect of a reform of a PEA and compare it to the effect of a reform of an unemployment benefit system. The *third* package of this reform (Hartz III) almost entirely deals with the reorganization of the agency.[8] Furthermore, implementation of Hartz III did not coincide with any other policy change assumed by the Hartz reform. Reduction of unemployment benefit generosity, in its turn, was the central objective of the *fourth* package (Hartz IV). Just like with the preceding package, no other policy change has been implemented together with this benefit reduction.

It should be noted that there were also elements of PEA improvements, namely the introduction of personnel service agencies and strengthening of sanctions, in the *first* package of the Hartz reforms. However PEA-related components of Hartz I were only a small fraction of the entire package and the composition of Hartz I is too complex to allow identification of these components within the entire spectrum of the package policies. Moreover Hartz I and II were implemented simultaneously, which complicates matters even further. For this reason we will take a conservative stance and measure the effect of the reform of the PEA by the effect of Hartz III exclusively.

3 Theory

3.1 The model

We formulate a Mortensen-Pissarides matching model with a duration-contingent effectiveness of the public employment agency in matching unemployed workers with vacant jobs and duration-dependent unemployment benefit payments.

Workers in our model are risk averse and ex ante heterogeneous with respect to observed skills and unobserved search productivities. Firms operate within skill-specific markets, each opening a vacancy for a particular skill level. Wages are set by collective bargaining and the government runs a balanced budget by financing unemployment benefits through the labour tax. We base our analysis on an extended model of Launov and Wälde (2013). The theoretical extension consists in allowing for duration-contingent matching effectiveness of the agency. This extension provides a unified framework that allows us to understand the effects of the PEA reform and compare these to the effect of a reform of the unemployment benefit system.[9]

[8] While there were also some sanctions introduced under Hartz III, they were negligible in duration. Namely, benefits could be revoked for one week if an individual fails to appear at the agency and for two weeks if an individual does not show enough commitment.

[9] For the time being we refrain from including a private search channel (as in Pissarides, 1979 or Fougère et al., 2009) in our analysis. Adding private search, we would expect that discouraged search of short-term unemployed via the PEA would encourage their search via the private channel. This would counteract the Pissarides effect and bring along another ambiguous effect on the unemployment rate. We believe this is worth being studied in future work.

- Matching effectiveness of the agency

Given the heterogenous approach to short-term and long-term unemployed workers by the Hartz III reform, we introduce a duration-contingent effectiveness of the PEA in matching unemployed workers with vacant jobs. Let s denote the duration of unemployment and let $\bar{s}$ denote the duration of entitlement to UI benefits. An unemployed worker is called short-term unemployed if $0 \leq s \leq \bar{s}$ and long-term unemployed if $s > \bar{s}$. The duration-contingent effectiveness of the PEA is given by

$$\psi(s) = \begin{cases} \psi^{UI}, & \text{for } 0 \leq s \leq \bar{s} \\ \psi^{UA}, & \text{for } s > \bar{s} \end{cases} .$$

It affects the exit rate of the individual from unemployment as described below in (3). The function $\psi(s)$ reflects both pre- and post-Hartz III institutional environments. Before the Hartz III reform, $\psi(s)$ is equal to unity irrespective of s. It takes values larger than one after the reform. Due to differential treatment of short-term and long-term unemployed by Hartz III, post-reform values of ψ^{UI} and ψ^{UA} are not equal to each other. Theoretically speaking, there are no restrictions on effectiveness, $\psi^{UI} \gtreqless \psi^{UA}$. Post-reform values are estimated below.

- Unemployment benefit system

Our model replicates the statutory two-step unemployment compensation system with UI benefits (b_{UI}), UA benefits (b_{UA}) and the time limit on UI benefits. With s and $\bar{s}$ as defined above, the benefits in our model are given by

$$b(s) = \begin{cases} b_{UI}, & \text{for } 0 \leq s \leq \bar{s} \\ b_{UA}, & \text{for } s > \bar{s} \end{cases} \tag{1}$$

where $b_{UI} > b_{UA}$. This system likewise reflects both pre- and post-Hartz IV institutional environments. Before the reform both b_{UI} and b_{UA} are proportional to the net wage paid by the last job. After the reform b_{UA} is replaced by the fixed ALG II amount.

Eligibility to UA benefits is means tested, with π^{UA} denoting the individual's probability (from the econometrician's viewpoint) of passing the means test. As means tests relate to family income and further individual circumstances, which are usually known to workers beforehand, workers know with certainty whether they will pass this test.

- Workers

Workers are ex ante heterogeneous with respect to skills and search productivity. Both skill level and search productivity level are innate and remain constant throughout the whole working life. The skill distribution $\{\pi(k)\}_{k=1}^{K}$ takes K distinct levels and is known to the worker upon entry into the market. The distribution of search productivity takes two distinct levels: 'low' and 'high', where π^{χ} is the population share of high-productive workers. Unemployed worker of skill k does not know with certainty how productive she is in search. Instead, at the beginning of each unemployment spell she has a prior belief about

being a high-productive type. We denote this initial subjective probability of being a high-productive type by $p_k(0)$. This probability will be updated in Bayesian fashion throughout the unemployment spell as described in (14) below.[10]

Unemployed workers of skill k receive benefits $b(s)$ and exert search effort $\phi_k(s)$ to look for jobs. Instantaneous utility $v(b(s), \phi_k(s))$ strictly increases in benefits and strictly decreases in search effort. We assume that the instantaneous utility function takes a CRRA form,[11]

$$v(b(s), \phi_k(s)) = \frac{1}{1-\sigma}\left[b(s)^{1-\sigma} - 1\right] - \phi_k(s). \tag{2}$$

While search effort brings disutility, it also increases the chances of contact with a vacancy available on the corresponding skill market. Contacts with firms arrive to workers at the (objective) rate

$$\mu_k(s, \chi) = ((1-\chi)\eta_{0,k} + \chi\eta_{1,k})\psi(s)[\phi_k(s)\theta_k]^{\alpha}, \quad \eta_{1,k} > \eta_{0,k} > 0 \ \forall k. \tag{3}$$

In this expression χ is an indicator variable that takes the value of 1 if the worker is high-productive in search (and $\chi = 0$ if low-productive); $\eta_{0,k}$ and $\eta_{1,k}$ are the skill-specific search productivity parameters of the contact rate of low- and high-productive types, respectively; α is the shape parameter of the contact rate, with $\alpha \in (0,1)$ such that returns to search effort are diminishing; θ_k is the tightness, i.e. vacancy-to-unemployment ratio, at the skill-specific market k. The matching effectiveness of the PEA, $\psi(s)$, enters the contact rate as an additional scale parameter, just as the search-type of an individual.[12]

Due to our Bayesian learning assumption, unemployed workers do not know their search productivity type with certainty. As a consequence, they do not know their objective job-arrival rate (3). They therefore need to work with a subjective probability $p_k(s)$ that they are of the high-productivity type. This implies a subjectively perceived contact rate which is the basis for all decisions of the individual. This subjective arrival rate is given by

$$\mu_k(s, p_k(s)) = \eta_k(s)\psi(s)[\phi_k(s)\theta_k]^{\alpha}, \tag{4}$$

where $\eta_k(s) = (1 - p_k(s))\eta_{0,k} + p_k(s)\eta_{1,k}$ is the expected search productivity parameter of the contact rate computed on the individual's subjective belief $p_k(s)$. Upon successful contact with a firm, unemployed workers get a job that pays the net wage w_k.

[10] We introduce a Bayesian learning process about one's job-search productivity as it allows us to account for the observed downward duration dependence in exit rates from unemployment at the empirical stage. As is well known, observed downward duration dependence arises either due to true duration dependence or due to unmeasured heterogeneity (or due to both of these factors simultaneously). The learning process in our theoretical model reflects the true duration dependence. Unmeasured heterogeneity is represented by a chance of not passing the means test.

[11] The choice of concave utility and linear cost of search functions is suggested by the standard identification result in empirical job search models, which tells that from duration and benefit data one can identify either concave utility and linear cost of search or linear utility and convex cost of search, but not both simultaneously. As our theoretical model is designed to be structurally estimable, the choice of (2) reflects this implicit identification assumption.

[12] If we derived the aggregate matching function implied by this job-arrival rate, we would see that an individual's search productivity and the effectiveness of the PEA affect total factor productivity of the matching function in a constant returns fashion. Individual effort and tightness, however, are subject to decreasing returns (at the same power α) as they are arguments of the matching function. This is the standard specification, see e.g. Pissarides (2000, ch. 5) for the case of effort and advertising.

Let $V_k(\psi(s), b(s), s)$ denote the value of unemployment at unemployment duration s in skill group k given the current state of the institutions: the PEA's duration-contingent effectiveness $\psi(s)$ and unemployment benefit $b(s)$. Furthermore, let $V(w_k)$ denote the value of a job at wage w_k. Unemployed workers choose search effort $\phi_k(s)$ to maximize their value of unemployment given their subjective probability of being a high-productive searcher. The Bellman equation for the value of unemployment reads

$$\rho V_k(\psi(s), b(s), s) = \max_{\phi_k(s)} \Big\{ v(b(s), \phi_k(s)) + \frac{d}{ds} V_k(\psi(s), b(s), s) + \mu_k(s, p(s)) [V(w_k) - V_k(\psi(s), b(s), s)] \Big\}, \quad (5)$$

where ρ is the rate of time preference. The first component under the max-operator shows the instantaneous utility of unemployment net of search costs. The second component is the deterministic change in the value of unemployment due to anticipation of the expiration of entitlement to UI and due to changes in the subjective probability of being high-productive in search. The last component is the expected gain from the transition to employment.

Once employed, individuals of skill type k receive the net wage w_k and do not search for jobs anymore, enjoying the utility $v(w_k) = \frac{1}{1-\sigma}\left[w_k^{1-\sigma} - 1\right]$. The worker-firm match is destroyed at the exogenous rate λ_k. Whenever losing the job, an individual starts the new unemployment spell with a restored full entitlement to UI benefits. Consequently, the Bellman equation for the value of employment reads

$$\rho V(w_k) = v(w_k) + \lambda_k [V_k(\psi(0), b(0), 0) - V(w_k)]. \quad (6)$$

The first component on the right hand side shows the instantaneous utility of employment and the second component reflects the capital loss due to job destruction.

- Firms

A worker-firm pair on the skill market k produces output A_k. Firms pay the gross wage $w_k^{gross} = w_k/(1-\kappa)$, where κ is the tax rate to finance unemployment benefits. Let $J(w_k/(1-\kappa))$ denote the value of a producing firm and let J_{0k} denote the value of the vacant firm on the corresponding skill market. Then the value of the producing firm solves

$$\rho J\left(\frac{w_k}{1-\kappa}\right) = A_k - \frac{w_k}{1-\kappa} - \lambda_k \left[J\left(\frac{w_k}{1-\kappa}\right) - J_{0k}\right]. \quad (7)$$

The term $A_k - w_k/(1-\kappa)$ on the right hand side of this Bellman equation shows the instantaneous profit. The remaining term illustrates the expected capital loss of the firm due to exogenous job destruction.

Vacant firms incur flow cost γ_k of advertising the vacancy. Vacancies meet unemployed workers at rate $\bar{\mu}_k/\theta_k$, where $\bar{\mu}_k$ is the expected job finding rate of skill group k. Adding up the averages over types χ, weighted by the respective sizes, $\bar{\mu}_k$ is given by

$$\bar{\mu}_k = \pi^{\chi} \int_0^{\infty} \mu_k(s,1) f_k(s,1)\, ds + (1-\pi^{\chi}) \int_0^{\infty} \mu_k(s,0) f_k(s,0)\, ds, \quad (8)$$

where $f_k(s,\chi)$ is the equilibrium probability density of unemployment duration of the workers with skill level k and search productivity χ. This density can be represented in terms of the hazard rate $\mu_k(s,\chi)$ from (3) as: $f_k(s,\chi) = \mu_k(s,\chi)\, e^{-\int_0^s \mu_k(y,\chi)dy}$.

We assume free entry into any of the k markets which drives the value of a vacant job down to zero, $J_{0k} = 0$. This reduces the Bellman equation for the value of the vacant firm to $\gamma_k = \theta_k^{-1}\bar{\mu}_k J(w_k)$, where the right-hand side captures the expected value of future production.

- The government

The government finances unemployment benefits through labour tax revenues. Let N_k denote the fixed measure of the labour force of skill k. Let L_k denote the endogenous measure of employment of skill k, such that $U_k \equiv N_k - L_k$ measures unemployment. Then, the measures of UI and UA recipients are given by

$$U_k^{UI} = (N_k - L_k)\left[\pi^{\chi}\int_0^{\bar{s}} f_k(s,1)\,ds + (1-\pi^{\chi})\int_0^{\bar{s}} f_k(s,0)\,ds\right], \tag{9a}$$

$$U_k^{UA} = (N_k - L_k)\left[\pi^{\chi}\int_{\bar{s}}^{\infty} f_k(s,1)\,ds + (1-\pi^{\chi})\int_{\bar{s}}^{\infty} f_k(s,0)\,ds\right]. \tag{9b}$$

The integrals in (9) reflect the share of individuals within the UI and UA range for specific types χ. Multiplying the π^{χ}-weighted overall share of, say, short-term unemployed workers in (9a) by the measure of unemployed workers gives the measure U_k^{UI} of short-term unemployed workers of skill k. The interpretation of (9b) is in analogy.

A measure $\sum_{k=1}^{K} U_k^{UI}$ of short-term unemployed workers receives UI benefits and the measure $\sum_{k=1}^{K} U_k^{UA}$ receives UA benefits. These are paid by the labour tax levied on the gross wage $w_k/(1-\kappa)$ of the employed workforce L_k. Consequently, the budget of the government is given by

$$b_{UI}\sum\nolimits_{k=1}^{K} U_k^{UI} + b_{UA}\sum\nolimits_{k=1}^{K} U_k^{UA} = \sum\nolimits_{k=1}^{K} \kappa\frac{w_k}{1-\kappa}L_k. \tag{10}$$

The government chooses the tax rate κ such that this budget is balanced at any time.

- Wages

Wages are set according to collective bargaining, where we explicitly account for risk-aversion as well as for the fact that UI and UA benefits are proportional to the previous net wage prior to the benefit reform. The collective value of employment in the case of successful bargaining for skill group k is given by the (individual) value of being employed at the wage w_k times the measure L_k of employed workers, $V(w_k)L_k$. Assuming that entitlement to UI payments is always given by $\bar{s}$ once a worker loses the job, the collective value of unemployment for skill-group k when bargaining fails is given by $V_k(\psi(0), b(0), 0)L_k$. The contribution of a single firm is given by the standard expression $J(w_k/(1-\kappa)) - J_{0k}$. Given a bargaining parameter β, the surplus of the match therefore

amounts to $(V(w_k) - V_k(\psi(0), b(0), 0))^{\beta} \quad (J(w_k/(1-\kappa)) - J_{0k})^{1-\beta} L_k$. Nash bargaining yields the wage equation for w_k that reads (see web appendix)

$$\begin{aligned}&(1-\beta)\, v(w_k) + \beta m_{w_k} w_k \\ &= (1-\beta)\, v(b_{UI,k}, \phi_k(0)) + \beta(1-\kappa)\, m_{w_k} \left[A_k + \gamma_k \theta_k \frac{\mu_k(0, p(0))}{\bar{\mu}_k}\right], \end{aligned} \tag{11}$$

where

$$m_{w_k} = v_w(w_k) + \frac{\lambda_k}{\rho + \mu_k(0, p(0))} v_w(b_{UI,k}, \phi_k(0)) \tag{12}$$

is the "generalized" marginal effect of w_k on instantaneous utility.

If we had risk-neutrality and wage-independent unemployment benefits, the marginal effect of the wage on utility in (12) would reduce to unity. In this case, the left-hand side of (11) would be equal to w_k, just as in the textbook model. In our more general setup, a marginal increase in the wage increases utility by the slope of the utility function at the current wage w_k plus the slope of the utility function at the future unemployment income $b_{UI,k}$ since the latter is a function of the current wage. This additional influence of the future unemployment income enters in expectation as jobs are lost at rate λ_k, appropriately discounted by the rate of time preference plus the job arrival rate $\mu_k(0, p(0))$ at the moment of entry in unemployment.

The right hand side of (11) shows the contribution of utility from benefits when just having lost the job and the tax-rate weighted effect of the production side. As in the standard setup, higher benefits yield higher wages, as does higher productivity. The effect of more vacancies per unemployed worker, i.e. of higher θ_k, is weighted by the arrival rate right after the job loss divided by the average arrival rate. This latter generalization is due to the non-stationary nature of benefit payments.

- Optimal behaviour and equilibrium

Given our specification of the instantaneous utility function in (2) and the specification of the subjective arrival rate in (4), optimal effort of job-searchers is determined by the first-order condition to (5) that reads (see web appendix)

$$\phi_k(s) = \left\{\alpha \eta_k(s)\, \psi(s)\, \theta_k^{\alpha} \left[V(w_k) - V_k(\psi(s), b(s), s)\right]\right\}^{1/(1-\alpha)}. \tag{13}$$

Effort rises in the individual's subjective mean search productivity $\eta(s)$ and in effectiveness $\psi(s)$ of the PEA. It also rises in the search incentives resulting from the difference between the value of being employed and the value of being unemployed.

At the heart of each Bayesian learning process is the updating of subjective beliefs. Unemployed workers that do not find a job observe that they are still unemployed. This objective information is combined with their subjective belief to be a good searcher. The resulting dynamics of the belief $p_k(s)$ of being high-productive in search is given by (see web appendix)

$$\frac{d}{ds} p_k(s) = -p_k(s)(1 - p_k(s))\left[\mu_k(s, 1) - \mu_k(s, 0)\right] < 0. \tag{14}$$

As the job-arrival rate of a good searcher $\mu_k(s,1)$ is always higher than the one for a bad searcher, $\mu_k(s,0)$, this equation tells us that the belief $p_k(s)$ falls over time for any skill group k. Intuitively speaking, the longer the duration in unemployment, the harder it is for an individual to keep up the belief that she actually has good abilities in searching for and finding a job.

Whether optimal search effort, $\phi_k(s)$, increases or decreases over time is determined by two mechanisms: (i) the anticipation of the fixed and known time limit to UI at $\bar{s}$ and (ii) Bayesian updating of individual beliefs. Depending on which force is stronger, the path can either have an inverted U shape or decrease monotonically with time. Both of these forces are functions of the model parameters, especially of the PEA's effectiveness ψ^{UI} and ψ^{UA} as well as of benefit payments b_{UI} and b_{UA}. Empirically, this solution is clearly much more flexible than a constant (even when endogenous) search effort level in a Mortensen-Pissarides setup without the fixed time limit to UI benefits and/or Bayesian updating. Once beyond $\bar{s}$, the optimal path of $\phi_k(s)$ is characterized by a negative duration dependence of the exit rate from unemployment $\mu_k(s, p_k(s))$. This ensures sufficient flexibility of the structural econometric model built subsequently on this prediction.[13]

Equilibrium in our model is constructed as follows. For a guess of the wage w_k and tightness θ_k, we can solve for value functions of workers, $V(w_k)$ and $V_k(\psi(s), b(s), s)$, effort $\phi_k(s)$ and beliefs $p_k(s)$. This guess is verified and an equilibrium tax rate κ and the value of a job $V(w_k)$ is computed in a second step that uses the budget constraint, the wage equation and the Bellman equation for a firm. This second steps solves simultaneously for all K skill groups. Once these equilibrium paths and values are established (see our web sites for the matlab code), we can compute equilibrium unemployment rates.

- Equilibrium unemployment

Characterization of the equilibrium unemployment rate in the model with time-dependent exit risk from unemployment requires a bit more elaboration than in a standard setup with time-invariant risks. Consider the following definitions. Let t denote the present moment of calendar time and let τ be the calendar time of some other moment in the future. Let $s(t)$ be the duration of occupancy of a given state of nature in t. Consider two states of nature: employment (e) and unemployment (u), and define indices i and j such that $i \in \{e,u\}$ and $j \in \{e,u\}$. Define by $P_{ij}^{k,\chi}(\tau, s(t))$ the probability of being in state j at the future moment τ for a k-χ individual (an individual of skill-group k and search type χ) who is currently in state i and whose duration of occupancy of state i is equal to $s(t)$. With this definition we can express the probability of being unemployed at some future moment τ, given that an individual is currently unemployed with duration $s(t)$ as

$$P_{uu}^{k,\chi}(\tau, s(t)) = e^{\int_t^\tau \mu_k(s(y),\chi)dy} + \int_t^\tau e^{\int_t^\nu \mu_k(s(y),\chi)dy} \mu_k(s(\nu)) P_{eu}^{k,\chi}(\tau-\nu, 0)d\nu. \qquad (15)$$

[13] A decreasing exit rate $\mu_k(s, p_k(s))$ is guaranteed for long-term unemployment by the falling subjective probability $p_k(s)$. From a purely empirical view, it is fairly hard to disentangle downward duration dependence due to $p_k(s)$ from other possible causes, such as for instance human capital depreciation. Therefore, even having estimated the model, we will not claim that the estimated path of $p_k(s)$ is free of confounding influences. If one would like to disentangle the evolution of subjective probability from other competing factors, these factors should be introduced in the theoretical model as well. Making such distinction, despite being interesting per se, is not the purpose of our analysis.

The probability of being unemployed at some future moment τ, given that an individual is currently employed with duration $s(t)$, is then given by

$$P_{eu}^{k,\chi}(\tau, s(t)) = \int_t^\tau e^{\lambda_k(\nu-t)} \lambda_k P_{uu}^{k,\chi}(\tau-\nu, 0) d\nu. \tag{16}$$

Equation (15) says that to be unemployed in τ conditional on being currently unemployed with duration $s(t)$ one can either remain unemployed continuously from t to τ or remain unemployed only up to any future moment ν, find a job at ν, which happens at rate $\mu_k(s(\nu), \chi)$, and later on be unemployed by τ again. The probability to be unemployed in τ again conditional on being employed in v is given by $P_{eu}^{k,\chi}(\tau-\nu, 0)$. Equation (16) tells us that in order to be unemployed in τ conditional on being currently employed with duration $s(t)$ one can lose a job at any future moment ν, which happens at rate λ_k, and later be unemployed by τ again, the probability of which is given by $P_{uu}^{k,\chi}(\tau-\nu, 0)$. Furthermore, since the job destruction rate is time invariant, $P_{eu}^{k,\chi}(\tau, s(t))$ is in fact independent of $s(t)$, so we can write $P_{eu}^{k,\chi}(\tau, s(t)) = P_{eu}^{k,\chi}(\tau)$. Finally note that $P_{uu}^{k,\chi}(\tau, s(t))$ and $P_{eu}^{k,\chi}(\tau)$ are interdependent, so (15) and (16) represent a system of two integral equations for these two probabilities.[14]

Knowing $P_{uu}^{k,\chi}(\tau, s(t))$ and $P_{eu}^{k,\chi}(\tau)$, one can compute the expected number of unemployed workers of skill k and type χ at any future moment τ,

$$E_\tau(N_{k,\chi} - L_{k,\chi}(\tau)) = (N_{k,\chi} - L_{k,\chi}(t)) \int_0^\infty P_{uu}^{k,\chi}(\tau, s(t)) dH_k(s(t), \chi) + L_{k,\chi}(t) P_{eu}^{k,\chi}(\tau), \tag{17}$$

where $N_{k,\chi}$ is the size of the labour force and $L_{k,\chi}(t)$ is the size of employment of skill k and type χ at t, and $H_k(s(t), \chi)$ is the corresponding cross-sectional distribution of unemployment duration at t. Dividing (17) by $N_{k,\chi}$ gives the expected skill-type unemployment rate at any future moment τ. Denoting by $u_{k,\chi}$ the long-term unemployment rate of k-χ workers and letting τ go to infinity one gets (see web appendix)

$$u_{k,\chi} = \frac{P_{eu}^{k,\chi}}{P_{eu}^{k,\chi} + \left[1 - \int_0^\infty P_{uu}^{k,\chi}(s) dF_k(s, \chi)\right]}. \tag{18}$$

$P_{uu}^{k,\chi}(s)$ and $P_{eu}^{k,\chi}$ in (18) are given by (15) and (16) for $\tau \to \infty$, and $F_k(s, \chi)$ is a steady state distribution of unemployment duration s of a skill-type group with a probability density function as shown on p.11.[15]

Aggregation over types for each skill gives the skill-specific unemployment rate $u_k = \pi^\chi u_{k,1} + (1-\pi^\chi) u_{k,0}$. Aggregation over all skills delivers the economy-wide unemployment rate $u = \Sigma_{k=1}^K \frac{N_k}{N} u_k$. Due to optimizing behaviour of individuals, u is a function of our two institutions: the PEA and the benefit system.

[14] The numerical solution builds on Schumm (2010, ch. 4). See our webpages for the implementation in matlab.

[15] Interestingly (and necessarily), the standard textbook expression $u = \lambda/(\lambda+\mu)$, suppressing dependence on k and χ, is a special case of our setup. When the job-finding rate is constant the corresponding probabilities become $P_{eu} = \lambda/(\lambda+\mu)$ and $P_{uu} = \lambda/(\lambda+\mu)$, delivering the result.

3.2 The intertemporal unemployment paradox

We now analyze the effect of a rising effectiveness of the PEA. As a starting point, consider a steady state that reflects the situation in Germany before *any* reform. It is instructive to first simulate the reform of a PEA where the increase in matching effectiveness of the agency is identical for short- and long-term unemployed, i.e. where $\psi(s) = \psi$. For this case, a rise of ψ by 1%, 3% and 5% reduces the unemployment rate by 0.17, 0.47 and 0.75 percentage points.[16] More generally, there is a monotone decreasing relationship between the effectiveness of the PEA on the one hand and the aggregate unemployment rate on the other, quite as expected.

The picture changes considerably when we allow for heterogeneous increases of the effectiveness of the PEA for short- and long-term unemployed workers. Our model displays an unemployment paradox: an increase in effectiveness of the agency can lead to an *in*crease in the unemployment rate. To illustrate the mechanism most clearly, let $\psi(s) = \psi^{UI} = 1$ when $0 \leq s \leq \bar{s}$ and $\psi(s) = \psi^{UA}$ when $s > \bar{s}$. We ask what is the effect of a change in ψ^{UA} on total hirings and the aggregate unemployment rate. The answer is plotted in Figure 2 for ψ^{UA} ranging between 0.8 and 1.4.

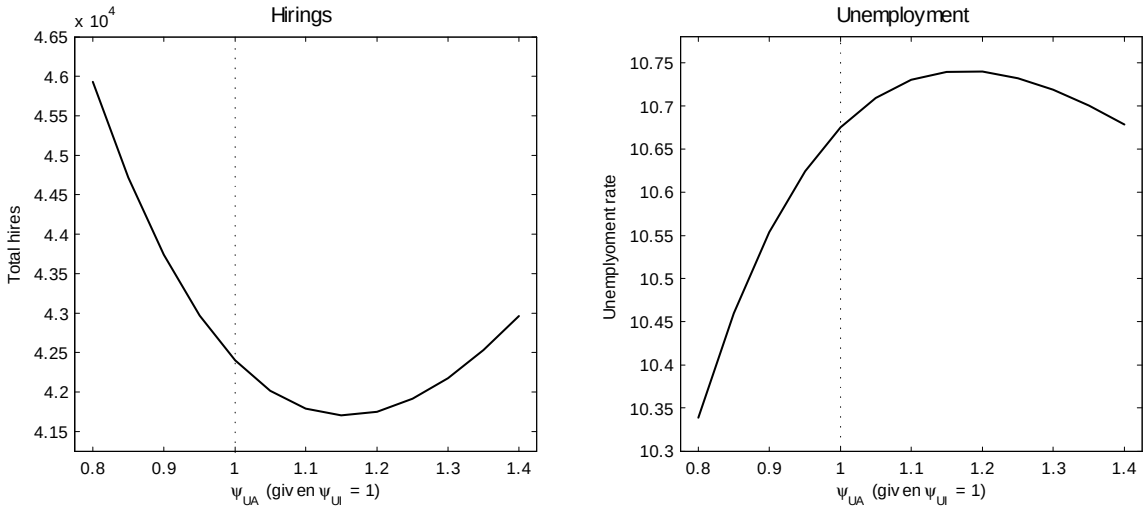

Figure 2 *The intertemporal unemployment paradox: Changes in total hirings and the unemployment rate as a function of matching effectiveness for long-term unemployed workers*

The left panel of this figure displays the aggregate number of matches and the right panel plots the aggregate equilibrium unemployment rate. This figure clearly shows the paradoxical effect: When effectiveness ψ^{UA} of the public employment agency rises for long-term unemployed workers, holding effectiveness ψ^{UI} of short-term unemployed fixed, hirings initially go down and unemployment increases. When effectiveness ψ^{UA} rises further, hirings rise again and unemployment falls.

[16] Parameter values for this analysis are given by the values from our estimation further below. The matlab code is available on our web sites.

This paradox emerges as there are two forces at work: A direct productivity effect for the long-term unemployed workers and an indirect disincentive effect for the short-term unemployed workers. The direct productivity effect *per se* is beneficial, i.e. higher productivity increases hirings and reduces the unemployment rate. The disincentive effect results from the anticipation by short-term unemployed workers that their exit rate will become higher once they are long-term unemployed. As a consequence, they reduce their search effort and the exit rate of short-term unemployed workers goes down. Total hirings tend to go down as well and unemployment rises. As either of the two effects can dominate, the non-monotonicity arises.

To back our intuition on the indirect incentive effect, consider the total number of matches M which in our model amounts to

$$M = \sum_{k=1}^{K} M_k = \sum_{k=1}^{K} \bar{\mu}_k U_k = \sum_{k=1}^{K} (\bar{\mu}_k^{UI} + \bar{\mu}_k^{UA}) U_k, \tag{19}$$

where M_k is the number of matches at the k-th market and where we call

$$\bar{\mu}_k^{UI} \equiv \pi^{\chi} \int_0^{\bar{s}} \mu_k(s,1) f_k(s,1)\, ds + (1-\pi^{\chi}) \int_0^{\bar{s}} \mu_k(s,0) f_k(s,0)\, ds, \tag{20a}$$

$$\bar{\mu}_k^{UA} \equiv \pi^{\chi} \int_{\bar{s}}^{\infty} \mu_k(s,1) f_k(s,1)\, ds + (1-\pi^{\chi}) \int_{\bar{s}}^{\infty} \mu_k(s,0) f_k(s,0)\, ds, \tag{20b}$$

the short-term and long-term exit rates, respectively. These exit rates illustrate averages for the intervals up to $\bar{s}$ and beyond.[17] The right-hand side of (19) implies that matches change when (i) the number of unemployed changes and (ii) the exit rates $\bar{\mu}_k^{UI}$ and $\bar{\mu}_k^{UA}$ change.

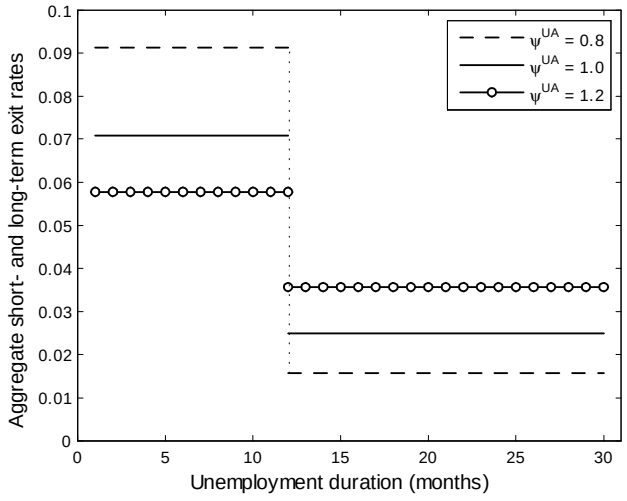

Figure 3 *Understanding the intertemporal unemployment paradox: Aggregate short-term and long-term exit rates as a function of matching effectiveness for long-term unemployed workers*

[17] Despite the identical structure as in (8), $\bar{\mu}_k^{UI}$ is *not* the average exit rate of short-term unemployed workers as the density is defined from 0 to infinity but the integral covers the range from 0 to $\bar{s}$ only. The same applies to $\bar{\mu}_k^{UA}$.

To confirm our intuition, Figure 3 fixes $\psi^{UI} = 1$ as in Figure 2 and depicts the aggregate exit rates, where aggregation is over k. It considers three different cases: $\psi^{UA} = \{0, 8, 1.0, 1.2\}$. The plain solid line is the agency that is equally effective for short- and long-term unemployed ($\psi^{UI} = \psi^{UA} = 1$). This is the benchmark. For the agency that is relatively more effective in the long term ($\psi^{UA} = 1.2$), the exit rate for long-term unemployed workers goes up, but the exit rate for short-term unemployed workers falls. This is exactly the effort reducing effect of anticipating higher PEA effectiveness in the future. The reverse would hold if the agency became relatively less effective in the long term ($\psi^{UA} = 0.8$): The exit rate rises for UI recipients and falls for UA recipients.

Summing up the discussion, it is an empirical question whether heterogeneous increases in PEA productivities were such that unemployment actually fell. It cannot be taken for granted, however, that *any* increase of productivities of an agency will lead to a reduction of the unemployment rate.

4 The impact of the reform of the agency

4.1 Econometric specification

- Data and estimation procedure

We estimate the effect of the reform of PEA using the following two-stage econometric procedure. At the first stage we estimate all parameters of the pre-reform steady state, in which effectiveness parameters of the PEA are normalized to unity. Structural parameters of the pre-reform steady state are estimated using maximum likelihood from survey data on individual employment histories. The data source is the German Socio-Economic Panel (see Appendix A.2 for a brief description). The entire structural econometric model for the pre-reform steady state of Section 3.1, together with discussion of identification and estimation results, is described in Launov and Wälde (2013). Since the *first* stage of the econometric analysis of the present paper and the entire econometric analysis of Launov and Wälde (2013) are identical, we borrow their estimation results for this paper and proceed to the second stage.

At the second stage, given the estimates of the structural parameters of the pre-reform steady state, we estimate the increase in matching effectiveness of the agency for short- and long-term unemployed, i.e. ψ^{UI} and ψ^{UA}. The impact of the reform is estimated using indirect inference (see Gourieroux et al., 1993, for indirect inference, and Postel-Vinay and Turon, 2010, for a similar two-step approach). The idea of indirect inference amounts to defining an auxiliary reduced-form econometric model and estimating this auxiliary model once on the real data and once on the synthetic data drawn from the structural model given the particular choice of the unknown structural parameters. Adjusting parameters of the structural model in such a way that the relevant moments of the auxiliary model estimated on the actual data and on the synthetic data coincide delivers indirect estimates of the structural parameters.

The real data we use are the regional data on the stocks of matches, unemployment and vacancies provided by the Federal Employment Agency (see Appendix A.2 for a brief

description).[18] The cross-sectional unit is a regional labour market, at the level of a federal Land, and the time unit is year. In the benchmark specification we analyze the period from 2000 to 2008, cutting the sample in 2008 to eliminate the effects of the Great Recession on the German labour market. After that we perform a sensitivity analysis adding year 2009 to check for robustness to the recession.[19] The synthetic data consist of the stocks of matches, unemployment and vacancies implied by the structural model of Section 3.1 given a particular choice of ψ^{UI} and ψ^{UA}. The cross-sectional unit is a 'skill'×'regional' labour market and the time unit is year. The benchmark estimation likewise relates to the period from 2000 to 2008, and the sensitivity analysis adds the year of the Great Recession. Both real and synthetic data allow making an explicit distinction between matches for short-term and long-term unemployed workers.

When specifying an auxiliary reduced-form model, even though parameters of such a model need not necessarily have a clear economic interpretation, auxiliary model needs to satisfy two requirements. First, it needs to resemble the structural model as close as possible (see Bagger et al., 2014). Second, it must have as close a fit to real data as possible. Since our application considers the impact of the increased effectiveness of PEA on the number of matches, the most natural choice for an auxiliary model is an empirical matching function.[20]

We consider a classical empirical matching function equation *à la* Blanchard and Diamond (1989) with matches on the left hand side and stocks of vacancies and unemployment, time trend and further explanatory variables on the right hand side. For the real data on short-term matches we write

$$\begin{aligned}\ln M_{it}^{\text{short}} &= \beta_{0,s} + \beta_{1,s}\ln U_{it}^{\text{short}} + \beta_{2,s}\ln V_{it} + \beta_{3,s}t + \beta_{4,s}t^2 + \beta_{5,s}d^{2005} \\ &\quad + \delta_s^{I\&II}HartzI\&II + \delta_s^{III}HartzIII + \delta_s^{IV}HartzIV + \iota_{i,s} + \epsilon_{it,s}, \\ &\quad \epsilon_{it,s} = \varphi_s\epsilon_{it,s} + \varepsilon_{it,s}, \quad \varepsilon_{it,s} \sim N\left(0, \sigma_{\varepsilon,s}^2\right), \quad \iota_{i,s} \sim N\left(0, \sigma_{\iota,s}^2\right),\end{aligned} \tag{21}$$

where $\iota_{i,s}$ stands for market-specific effects on the matches of short-term unemployed workers and $\epsilon_{it,s}$ follows a first-order autoregressive process with coefficient φ_s. Similarly, for the real data on long-term matches we write

$$\begin{aligned}\ln M_{it}^{\text{long}} &= \beta_{0,l} + \beta_{1,l}\ln U_{it}^{\text{long}} + \beta_{2,l}\ln V_{it} + \beta_{3,l}t + \beta_{4,l}t^2 + \beta_{5,l}d^{2005} + \beta_{6,l}d^{2006} \\ &\quad + \delta_l^{I\&II}HartzI\&II + \delta_l^{III}HartzIII + \delta_l^{IV}HartzIV + \iota_{i,l} + \epsilon_{it,l}, \\ &\quad \epsilon_{it,l} = \varphi_l\epsilon_{it,l} + \varepsilon_{it,l}, \quad \varepsilon_{it,l} \sim N\left(0, \sigma_{\varepsilon,l}^2\right), \quad \iota_{i,l} \sim N\left(0, \sigma_{\iota,l}^2\right),\end{aligned} \tag{22}$$

where $\iota_{i,l}$ and $\epsilon_{it,l}$ have the same interpretation as $\iota_{i,s}$ and $\epsilon_{it,s}$ above.

[18] The same data set was used for estimation in Klinger and Rothe (2012). We are grateful to Sabine Klinger and Thomas Rothe for making these data available to us.

[19] Officially Germany entered the recession in the 2nd quarter of 2008, and the recession lasted for one year. Despite that, German unemployment rate kept falling until the end of 2008. During the first three quarters of 2009 it has been on the rise and then it started falling again reaching the pre-recession level by the end of 2009 (see e.g. OECD, 2014). Therefore we rather choose year 2009 to relfect the influence of the Great Recession.

[20] We are not the first to make such a choice. Empirical matching function has been already used by e.g. Fahr and Sunde (2009) and Klinger and Rothe (2012) to analyze the effect of different packages of the Hartz reform in Germany on the number of matches. For a review of related applications of empirical matching functions see Petrongolo and Pissarides (2001).

The variable of our primary interest in (21) and (22) is $HartzIII$. This is the dummy variable that captures the impact of the reform of the PEA on matches. It takes the value of "0" before 2004 and "1" from 2004 onwards. This variable is the only explanatory variable in (21) and (22) pertinent to the reform of the PEA. The rest of the variables control for changes in economic environment unrelated to time trend and the PEA reorganization. $HartzI\&II$ controls for the effect of the first two packages of the reform, taking the value of "0" before 2003 and "1" thereafter. $HartzIV$ does the same for the effect of the last package of the reform with a value of "0" before 2005 and "1" afterwards. Finally, two dummy variables, d^{2005} and d^{2006} account for structural breaks in the statistics on unemployed workers. Dummy d^{2005} (= 1 in 2005) reflects the fact that in 2005 former recipients of social assistance benefits had to register as unemployed; dummy d^{2006} (= 1 in 2006) accounts for introduction of new statistics in municipalities that were taking care of long-term unemployed on their own (see Klinger and Rothe, 2012, for more details).

We estimate ψ^{UI} and ψ^{UA} by matching estimates of δ_s^{III} and δ_l^{III} from the regression on the real data with estimates of δ_s^{III} and δ_l^{III} from the regression on the synthetic data given a particular choice of ψ^{UI} and ψ^{UA}. The synthetic sample captures growth over the period of 2000-2008/09 by conditioning on changes in labour productivity taken from OECD (2014). A bias from other packages of the reform as well as from structural breaks in unemployment statistics is eliminated from the synthetic sample simply by not simulating these packages and breaks. With two parameters to match and two parameters to estimate the identification is exact. Estimates of ψ^{UI} and ψ^{UA} are obtained by application of the equally weighted minimum distance estimator. Low dimensionality of the estimation problem allows using grid search.

- Simulation of the reform

Once estimates of ψ^{UI} and ψ^{UA} are available, the impact of the PEA reform (Hartz III) is measured by the difference in equilibrium unemployment rates before and after the reform, net of labour productivity growth. In addition, we want to know how the impact of the improved PEA compares to the impact of the reform of the benefit system, which followed thereafter. To simulate the effect of the benefit reform (Hartz IV), we do not need any additional estimation. We look at each of the 'skill'×'regional' markets. We consider the observed distribution of UA payments immediately before the reform and the observed distribution of ALG II payments immediately after the reform. The difference in mean values of these distributions marks skill-specific changes in the benefit level due to introduction of ALG II. Skill-specific changes in the duration of entitlement to UI are treated in the same way. The impact of the entire benefit reform is measured by the difference in the equilibrium unemployment rates before and after the benefit and entitlement cut, net of labour productivity growth.

Lastly, one might be tempted to suggest that using the very same indirect inference approach one could estimate the influence of Hartz I and II left out in the present paper. While not unthinkable, the essential difficulty with this suggestion is that Hartz I and II include a whole set of measures which affect individual behaviour in diverse ways. If one attempts to introduce at least the most important measures into the structural model, one would immediately run into an identification problem, as equations (21) and (22) each contain

only one coefficient $\delta_j^{I\&II}$ to identify more than one structural parameter, $j = s, l$. Extending the set of auxiliary regressions to insure identification, and of course extending the theoretical model for multitude of policies under Hartz I and II, is a project in itself.

4.2 Estimation results

Let us now consider the estimation results for all the structural parameters. Characteristics of the pre-reform steady state and estimates of the structural parameters from the first stage are reported in Table A.1 of Appendix A.2. Estimates of the effectiveness parameters of the agency from the second stage are reported in Table 1 below.

The left block of Table 1 shows estimates of the parameters of interest from the auxiliary regressions (δ_{short}^{III} and δ_{long}^{III}). The right block of this table shows estimates of the corresponding structural parameters. Details on estimation of auxiliary regressions are relegated to Appendix A.3, with an entire set of estimation results for these regressions reported in Table A.3. Here we just note that a quadratic time trend is supported only in the equation for short-term unemployed, that the time trend is linear for long-term unemployed, and that auxiliary regressions have a very good fit to the real data.

The left block of Table 1 underlines the exceptionally high accuracy of our estimation procedure. First, the distance between reduced-form coefficients estimated from the real data and synthetic data is negligible both for short-term and long-term matches. Second, t-statistics in the test of pairwise equality of the coefficients of interest estimated from the real and synthetic data have extremely small values in both regressions. This adds confidence to the accuracy of our indirect estimates of ψ^{UI} and ψ^{UA}, taking the auxiliary model as given. Later on we also perform sensitivity analysis with respect to the specification of the auxiliary model.

	Auxiliary regressions			**Structural parameters**
	real data	*synthetic data*		
δ_{short}^{III}	0.0684 (0.0191)	0.0685 (0.0088) [−0.0042]	ψ^{UI}	1.076 (0.020)
δ_{long}^{III}	0.0601 (0.0333)	0.0601 (0.0073) [−0.0001]	ψ^{UA}	1.230 (0.024)

Standard errors in parenthesis; t-statistic for a test of pairwise equality of estimated coefficients on real and synthetic data in square brackets. Standard errors for structural parameters disregard the first stage.

Table 1 *Impact of the reform on matching effectiveness of the agency*

Indirect estimates of the structural parameters of the PEA effectiveness, reported in the right block of Table 1, reveal an interesting result. They show that the effectiveness of the agency in matching short-term unemployed workers with vacant jobs has increased by 7.6% due to the reform. Effectiveness of the agency in matching long-term unemployed

has increased by as much as 23.0%. Both increases are significant, emphasizing that the reform of the Federal Employment Agency in Germany was a success in terms of reducing coordination frictions between unemployed workers and vacant jobs. Furthermore we can see that the reform has improved the situation for long-term unemployed workers significantly more.

Such results on ψ^{UI} and ψ^{UA} give rise for two intriguing questions. First, what is the impact of the increase in matching effectiveness by 7.6% for short-term and by 23.0% for long-term unemployed workers on the equilibrium unemployment rate? Second, in view of discussion of Section 3.2, how big is the disincentive effect of the unequal increase in the matching effectiveness for short- and long-term unemployed workers? We answer these questions next.

4.3 Evaluation of the reform

- Equilibrium impact of the reform

Table 2 summarizes the computed fall of the equilibrium unemployment due to the improvement of the PEA and the subsequent reduction of benefit generosity. Already the first row of this table shows one of the key results of the present analysis. We see that the 7.6% increase in matching effectiveness of the agency for short-term unemployed and 23.0% increase in matching effectiveness for long-term unemployed lead to a 0.88 percentage point reduction of the unemployment rate. This reduction amounts to 22.51% of the observed decline in unemployment in Germany between the implementation of the last package of the Hartz reform and the beginning of the Great Recession. It establishes that the reform of the PEA in Germany holds a substantial stake in the way unemployment has been managed before the world financial crises erupted.

		Unemployment reduction	
		absolute (ppt)	*explained (%)*
(1)	Hartz III	0.88	22.51
(2)	Hartz IV	0.08	2.05
(3)	Hartz III and IV	1.06	27.11
(4)	Hartz IV given Hartz III [a)]	0.18	4.60
(5)	Interaction of Hartz III and Hartz IV [b)]	0.10	2.56

[a)] Line (3) minus line (1) [b)] Line (4) minus line (2)

Table 2 *Reduction of the unemployment rate explained by reforms*

Considering the public attention devoted to each package of the Hartz reform at the time, this result comes somewhat as a surprise, since the reform of the Federal Employment

Agency was the package least publicized of all four. Just in contrast, it was the UA benefit cut and the reduction of entitlement duration to UI that stirred media and public debates most. Our next result shows what is the actual impact of the benefit reform and what is the contribution of the preceding reform of the PEA to the strength of this impact. The benefit reform is evaluated using the reduction of UA benefits and duration of entitlement to UI reported in Table A.2 of the Appendix A.2.

The equilibrium effect of the benefit reform can be computed in two ways. First, we can evaluate this effect as if there was no reform of the PEA before. Line (2) of Table 2 tells us that in such a case a reduction of benefit generosity under arrangements of Hartz IV would lead to just 0.08 percentage point fall in the equilibrium unemployment rate. This amounts to very modest 2.1% of the observed decline in unemployment, suggesting that the undertaken reduction of benefit generosity is by far not sufficient to influence the unemployment rate in a tangible way. Second, we can compute the impact of the reform of the PEA and benefits sequentially and see what is the effect of the benefit reform given that improvement of the PEA has taken place prior to benefit and entitlement cuts. Line (3) of Table 2 displays the joint impact of both reform packages, showing a 1.1 percentage point reduction of the equilibrium unemployment rate as a consequence. It conveys that both packages explain 27.1% of the observed post-reform decline in unemployment. Taking the net effect of the benefit reform conditional on the reform of the PEA, which is done in line (4) of Table 2, we find that the benefit reform leads now to 0.18 percentage point reduction in the equilibrium unemployment rate. This more than doubles the unconditional effect and explains already 4.6% of the observed post-reform unemployment decline.

Thus we find that improvement of the PEA prior to benefit reform has actually amplified the effect of the benefit reform. This amplification takes place because considerable increase in matching effectiveness of the PEA for long-term unemployed pushes up the value of long-term unemployment. Consequently, elasticity of the exit rate out of unemployment with respect to UA benefits becomes higher, which leads to stronger reaction to one and the same benefit cut. The size of this amplification effect due to the reform of the agency is reported in line (5) of Table 2: 0.10 percentage points.[21]

Summarizing the above analysis we find that the reform of the Federal Employment Agency in Germany accounts for 0.88 percentage points (or 22.5%) of the decline in the unemployment rate, whereas the subsequent reduction of benefit generosity adds only 0.18 percentage points (or 4.6%) to this decline. Moreover, 0.10 of these 0.18 percentage points due to reduction of benefit generosity were indeed assisted by the preceding improvement of the PEA. This underlines that in a typical welfare state an improvement of effectiveness of state employment agencies may have a much stronger influence on unemployment than unemployment benefit cuts of acceptable size.

- Quantifying the unemployment paradox

The last point we would like to make concerns the disincentive effect discussed in Section 3.2. First of all, line (1) in Table 2 suggests that the positive effectiveness effect is unambiguously stronger than the negative incentive effect, since the net influence of the reform

[21] This finding also adjusts upwards the earlier estimate of the effect of the benefit reform by Launov and Wälde (2013), who disregarded the reform of PEA. Their impact of the benefit reform was as in line (2) of Table 2.

reduces the unemployment rate. Yet, the Hartz III reform could have been designed in a more efficient way. Consider the alternative where the increase in matching effectiveness both for short- and long-term unemployed workers is at the level we find for short-term unemployed workers in the actual design (i.e. by 7.6% for both categories of unemployed). Obviously, this counterfactual alternative is less costly to the government than the actual one. Furthermore, it is free of the disincentive effect discussed in Section 3.2. We ask what would have been the reduction of the equilibrium unemployment rate if this counterfactual alternative would have been implemented in place of the actual design.

Our calculations show that an equal increase in matching effectiveness of the agency for short- and long term unemployed workers by 7.6% would have reduced the unemployment rate by as much as 1.09 percentage points. This *exceeds* the 0.88 percentage point reduction attained by the actual design by 0.21. Thus, taking for granted that the actual design is more costly than the counterfactual one, we conclude that the actual design is clearly suboptimal. If the special emphasis on long-term unemployed workers had been avoided, the unemployment rate would have been reduced even more.[22]

4.4 Sensitivity analysis

Let us now analyze how sensitive are our indirect estimates of ψ^{UI} and ψ^{UA}. As mentioned in Sections 4.1 and 4.2, there are two dimensions of this sensitivity analysis: (i) sensitivity with respect to specification of the auxiliary model, and (ii) sensitivity to inclusion of the Great Recession.

- Specification of the auxiliary model

Discussion on the estimation of auxiliary models (see Appendix A.3) concludes that the absence of the relevant critical values does not allow us to formally accept or reject first order autoregressive process in the error terms of both auxiliary regressions. All our results so far relied on auxiliary regressions with first order autoregressive process in the error terms, which we kept in order to be as general as possible. In what follows we consider an alternative specification where error terms in both auxiliary regressions are white noise. Results from this alternative specification are reported in Table 3, which should be read in the same way as Table 1.

Table 3 shows that regardless of the change in specification of the error term in auxiliary regressions, the accuracy of indirect estimation remains very high. This is evident from the distance between estimates of δ^{III}_{short} as well as δ^{III}_{long} on the real and synthetic data; this is also supported by the corresponding values of t-statistics. We further see that the increase in matching effectiveness of the PEA is now equal to 6.1% for short-term and 22.9% for long-term unemployment workers. As before, both effects are statistically significant. However the estimate of ψ^{UI} falls a bit short of the previously estimated value of 7.6%. The estimate of ψ^{UA}, to the contrary, remains insensitive to the change in specification of auxiliary regressions.

[22] One could go beyond our analysis by inquiring into an *optimal* design of a PEA reform. For a quantification, one would need a measure of the cost of improving effectiveness of the agency for short- and long-term unemployed workers. Such a measure is not immediately available, however.

	Auxiliary regressions			Structural parameters
	real data	*synthetic data*		
δ^{III}_{short}	0.0279 (0.0210)	0.0280 (0.0084) [−0.0009]	ψ^{UI}	1.061 (0.003)
δ^{III}_{long}	0.0417 (0.0280)	0.0418 (0.0114) [−0.0029]	ψ^{UA}	1.229 (0.003)

Standard errors in parenthesis; t-statistic for a test of pairwise equality of estimated coefficients on real and synthetic data in square brackets. Standard errors for structural parameters disregard the first stage.

Table 3 *Sensitivity to specification: Impact of the reform on matching effectiveness of the agency*

We ask whether the detected difference between estimates of ψ^{UI} across different specifications of auxiliary regressions results in a big difference in the predicted decline of the unemployment rate. We repeat the entire equilibrium analysis, evaluating first the PEA reform and then the reform of the benefit system. Results of this analysis are reported in Table 4, which should be read in the same way as Table 2. We find that the reform of the PEA leads now to a 0.69 percentage point decline in the equilibrium unemployment rate, which explains 17.7% of the observed fall in unemployment. Comparing it to 0.88 percentage points (equivalently, 22.5%) we see that the result is indeed slightly sensitive to the specification of auxiliary regressions. The impact of the subsequent benefit reform, however, remains virtually unaffected: 0.20 percentage points, or 5.1 % (compared with 0.18 percentage points and 4.6% in Table 2, respectively).

		Unemployment reduction	
		absolute (ppt)	*explained (%)*
(1)	Hartz III	0.69	17.65
(2)	Hartz IV	0.08	2.05
(3)	Hartz III and IV	0.89	22.76
(4)	Hartz IV given Hartz III[a)]	0.20	5.12
(5)	Interaction of Hartz III and Hartz IV[b)]	0.12	3.01

[a)] Line (3) minus line (1) [b)] Line (4) minus line (2)

Table 4 *Sensitivity to specification: Reduction of the unemployment rate explained by reforms*

Even though we believe that first-order autoregressive processes in the error terms of both auxiliary equations are very likely to survive with more observations, we prefer to report our final results in terms of intervals. Thus, summing up, the reform of the PEA induces a 0.69 to 0.88 percentage point reduction of the equilibrium unemployment rate, which translates into 17.7% to 22.5% of the observed post-reform decline of unemployment in Germany. The subsequent benefit reform induces a 0.18 to 0.20 percentage point reduction of the equilibrium unemployment rate, explaining further 4.6% to 5.1% of the observed post-reform unemployment decline. The dominant effect of the reform of the agency over the reform of the benefit system clearly survives this sensitivity analysis.

Lastly, implications of an alternative design that alleviates the disincentive effect remain virtually insensitive to the change in the specification of the auxiliary regressions. Considering the counterfactual design that increases effectiveness of the agency for short- and long-term unemployed workers equally by 6.1%, instead of raising it to 22.9% for the long-term unemployed as in the actual design, we find that this counterfactual design leads to a 0.9 percentage point reduction of the unemployment rate. This again exceeds the reduction implied by the actual design by 0.21 percentage points, exactly as with the initial specification of the auxiliary regressions. Thus all of our conclusions on the suboptimality of the actual reform are confirmed.

- Adding the Great Recession

Consider now the inclusion of the recession. We extend our sample by one year and add to specification of auxiliary regressions in (21)-(22) a dummy variable d^{2009} that accounts for recessionary drop in matches. Dummy d^{2009} takes the value of "1" if year is 2009, zero otherwise. Estimation accuracy in this part of the sensitivity analysis is a high as in all preceding parts, so to be brief we skip reporting the estimates of δ^{III}_{short} and δ^{III}_{long} (these can be found in Table A.3 of Appendix A.3).

	$\varphi_s \neq 0$, $\varphi_l \neq 0$		$\varphi_s = 0$, $\varphi_l = 0$	
ψ^{UI}	1.083	(0.003)	1.081	(0.004)
ψ^{UA}	1.251	(0.026)	1.271	(0.004)
	Unemployment reduction		Unemployment reduction	
	abs. (ppt)	*expl. (%)*	*abs. (ppt)*	*expl. (%)*
Hartz III	0.94	24.04	0.90	23.02
Hartz III and IV	1.13	28.90	1.10	28.13
Hartz IV given Hartz III	0.19	4.86	0.20	5.12

Table 5 *Sensitivity to adding the Great Recession*

Table 5 summarizes all the results. Upper part of this table shows the estimated values of the structural parameters ψ^{UI} and ψ^{UA}. Its lower part displays the predicted reduction of the unemployment rate due to the reforms of interest. We add the effect of the recession within two specifications. The benchmark specification (first two columns of Table 5) keeps autoregressive terms in the errors of both auxiliary regression equations. The restricted specification (last two columns of Table 5) removes autoregressive terms.

Comparing the results in Table 5 with the corresponding results of Tables 1 and 2 we see that our findings on the reform of the PEA are hardly sensitive to inclusion of the Great Recession. The predicted contribution of Hartz III to the reduction of the unemployment rate is at most 0.06 percentage points higher, which is negligible. The same can be said about the estimates of the effectiveness parameters of the agency. Furthermore, our earlier results on the role of the benefit reform and on the importance of this reform relative to reorganization of the PEA remain completely insensitive. Finally it is interesting to notice that having extended the time horizon and having included the recession, our findings in Table 5 cease to differ across specifications of the error term in auxiliary regressions. Even though we still prefer to report our final results in terms of an interval, alleviation of the sensitivity with respect to specification adds confidence that the true impact of the reform of the PEA lies in the upper range of this interval.

4.5 Reform implications

What do we learn from this analysis for future reforms? There is a discussion in Germany on a second Hartz-type reform and, much more importantly, there is a discussion at the European level on how to fight the highest unemployment rates in the Euro area ever since the Euro has been introduced.[23] How can policy measures be informed by our findings?

In some trivial sense, anything that increases the outflows from and reduces the inflows into unemployment is desirable. It is less trivial to suggest measures that actually increase outflows and reduce inflows. The most challenging task consists in quantifying the effects of the suggested measures. Our analysis makes a strong case for an increased effectiveness of the PEA. What speaks in favour of more effective PEA as opposed to a cut of benefits for long-term unemployed? First, the strong direct effect on the increase of outflows from unemployment. A more efficient PEA does not only increase outflow of long-term unemployed workers - once appropriately tuned, it benefits all unemployed workers. Second, the neutrality of a such a policy measure with respect to distributional considerations. While a cut of benefits for long-term (or all) unemployed workers should increase outflows (if only modestly as we have found), it increases income inequality and poverty.

Is there a direct recommendation for "any" country with high unemployment? We would say no when it comes to *detailed* reform measures. Our findings strongly suggest, however, that any country should first look into possibilities of making its PEA more effective before thinking about reducing unemployment benefits. From reading descriptions of the reform of the Federal Employment Agency in Germany, the best conclusions on which components were the most important ones are the following. (i) There is one contact person for all aspects related to unemployment for the unemployed worker. (ii) Short questions are relegated

[23] See e.g. the new release 50/2013 of 2 April 2013 by Eurostat.

to call-centers. (iii) More time-intensive consultations are by appointment only, reducing considerably waiting times in the agency. (iv) Characteristics of an unemployed worker and parameters of an open vacancy are standardized to facilitate quicker matching by the case-worker.[24] (v) The number of unemployed managed by a caseworker is reduced to the benchmark of at most 150, of which at most 75 are under age of 25 years. (vi) Priority is given to workers above the age of 50.[25] The Annual Report of the Federal Employment Agency (Bundesagentur für Arbeit, 2013, p.43) provides empirical confirmation that the quantitative benchmarks in (v) have actually been met, though only in 2012.

The implication of homogeneous versus heterogeneous impact design of the reform should not be forgotten as well. As our estimates indicate, the PEA reform would have had a higher effect on the reduction of unemployment if short- and long-term unemployed would have benefited equally. Thus, from a design perspective, the reform should probably not condition on unemployment duration.

5 Conclusions

We evaluate the impact of a reform of a public employment agency on unemployment in a typical welfare state economy. For this purpose we use a version of a Mortensen-Pissarides matching model extending it for a time-dependent matching effectiveness of the agency.

In our theoretical model, we first demonstrate that an increase in matching effectiveness of the agency does not necessarily lead to a reduction of the unemployment rate. This is our intertemporal unemployment paradox. It occurs when there is a preferential treatment of long-term unemployed workers. If long-term unemployed workers are treated more efficiently in comparison to the short-term unemployed, the latter anticipate the improvement of treatment in the future, which reduces their current search effort. The combination of discouraged search activity of the short-term unemployed workers and boosted search activity of the long-term unemployed workers has an ambiguous net effect on the aggregate unemployment rate.

Second, we structurally estimate the impact of the reform of the public employment agency, aimed at improving matching effectiveness of the agency for short- and long-term unemployed workers in Germany. The design of this reform, also known as Hartz III reform, treated short- and long-term unemployed workers differently. Using estimation by indirect inference, we find that the improvement of the public employment agency has substantially contributed to the reduction of unemployment in Germany. Comparing pre- and post-reform steady states, the reform of the agency becomes responsible for the fall of the equilibrium unemployment rate by 0.69 to 0.88 percentage points. This explains from 17.6% to 22.5% of the observed post-Hartz decline in German unemployment.

Third, we find that the present design of the reform, which has turned out to favour long-term unemployed workers about three times more than short-term ones, appears to be

[24] An impressive description, albeit in German, is by Weise (2011), the current head of the Federal Employment Agency. It strongly makes the case that the reorganization of all work-flows turned an administrative bureaucracy (that became fraudulent in parts of its activities) into a customer (i.e. employee and employer) oriented service center.

[25] These benchmarks are from SGB II § 44c paragraph 4 in *Bundesgesetzblatt* 2011, part I, Nr.23, p.852-891.

suboptimal. If *less* attention had been paid to long-term unemployed workers, the unemployment rate would have fallen even more as a result of the PEA reform. This suggests the policy conclusion that reforms of public employment agencies should not make such big differences between different types of unemployed workers. The mechanism behind the result is again the intertemporal unemployment paradox.

Fourth, we make a strong case for improvement of the public employment agency as opposed to reduction of allegedly generous unemployment benefits. We compare the reform of the agency to the reduction of benefit generosity which took place in Germany under arrangements of the so-called Hartz IV reform, following Hartz III. We show that the benefit reform, which assumed shortening of entitlement to unemployment insurance and moderate cuts of unemployment assistance benefits, has indeed brought a very modest result. It has added only 0.18 to 0.20 percentage points to further fall of the equilibrium unemployment rate, explaining just 4.6% to 5.1% of the observed post-Hartz unemployment decline. Given the amount of public debates that were surrounding the reduction of benefit generosity, we conclude that benefit cuts big enough to generate the effect comparable to the reform of the agency lie very likely outside the range of possible political compromise.

We see the primary contribution of this paper in discovering a substantial unemployment-reducing potential in typical welfare states. This potential is locked in inefficient public employment agencies. There exists a rich literature that addresses different labour market institutions of a welfare state and analyzes how reforming these institutions can help us reduce unemployment. Unemployment compensation systems, trade unions, labour taxes or subsidies and employment protection are all among the most frequently analyzed institutions. Surprising as it is, in this list one cannot find the public employment agency itself. With our findings that about 1/5 of the post-reform decline in unemployment can be attributed to their reorganization, public employment agencies and their modernization must not be overlooked by policy makers and by academic researchers alike.

Appendix

A.1 The literature on Hartz reforms

In principle, all labour market regulations and their changes are documented in the corresponding laws ('Sozialgesetzbüchern'). As a starting point on labour market policy and how it is encoded in the law, see Keller and Henneberger (2010). Considering the first, second and third packages of the reform, the basic law is "SGB III - Arbeitsförderung" (*Bundesgesetzblatt* 1997, Teil I, Nr.20, p.595-689). Amendments to this law through Hartz I, Hartz II and Hartz III are in "Erstes Gesetz für Moderne Dienstleistungen am Arbeitsmarkt" (Bundesgesetzblatt 2002, Teil I, Nr.87, p.4607-4616), "Zweites Gesetz für Moderne Dienstleistungen am Arbeitsmarkt" (Bundesgesetzblatt 2002, Teil I, Nr.87, p.4621-4636) and "Drittes Gesetz für Moderne Dienstleistungen am Arbeitsmarkt" (Bundesgesetzblatt 2003, Teil I, Nr.65, p.2849-2886), respectively. Regarding the fourth package, the basic law is "SGB II - Grundsicherung für Arbeitssuchende" (*Bundesgesetzblatt* 2003, Teil I, Nr.66, p.2955-2971). This law is the first article of the "Viertes Gesetz für Moderne Dienstleistungen am Arbeitsmarkt", i.e. of Hartz IV. Moreover, amendments to SGB III by Hartz IV

are in "Viertes Gesetz für Moderne Dienstleistungen am Arbeitsmarkt" (Bundesgesetzblatt 2003, Teil I, Nr.65, p.2971-2975). Distilling out the changes due to the Hartz reforms from reading these laws is a research project on its own. This is why we additionally rely on the literature.

The existing literature is huge and ranges from newspaper to scientific articles. Most of these articles have a strong policy and political orientation. Here is a list of articles on which we base our summary in the main text. Kaltenborn et al. (2006a) provide a summary of the structure and evaluations of Hartz I, II and III. The long version is the report by the Bundesregierung (2005). An even more extensive version is the report by the Bundesministerium für Arbeit und Soziales (2006). Based on the latter, Kaltenborn et al. (2006b) provide a list of various measures introduced by the reform (see their Table 1).

In addition, the core elements of the Hartz reforms are worked out by Jacobi and Kluve (2007). Weise (2011), the head of the "Bundesagentur für Arbeit", provides a clear description of the effects of Hartz III with respect to the reorganization of the German PEA. Schuetz and Oschmiansky (2006) also emphasize the importance of the reorganization of the German PEA. Heyer et al. (2012) provide an overview on active labour market policy aspects of the reform.

A website providing a good review of reform contents (despite not being completely up to date) is WIPOL (2006).

A.2 Data

In what follows we provide a brief overview of the data used at the first and second stages of our structural estimation procedure.

- First stage

Table A.1 provides the complete characterization of the steady state before any reform. Sources for this table are the German Socio-Economic Panel (GSOEP, www.gsoep.de) for wage and benefit data along with all group characteristics; the IAB (www.iab.de) for vacancy and unemployment data and Launov and Wälde (2013) for the sample taken from GSOEP and all the structural parameters. All monetary values are in Euros of 2005.

The skill distribution $\{\pi(k)\}_{k=1}^{K}$ in the economy relates to the sample taken from the entire population of working age individuals. The rest of the observed data, except of labour market tightness and unemployment rate, stems from the flow sample of entrants into full-time employment and unemployment between 01.2001 and 12.2003. Reported UA benefits $\tilde{b}_{UA,k}$ are conditional on eligibility to UI benefits (an event happening with probability π_k^{UI}) and on passing the means test upon expiration of entitlement to UI (an event happening with probability π^{UA}). Expected benefit $b_{UA,k}$ used in the quantification of the pre-reform steady state is therefore defined as $b_{UA,k} \equiv \pi_k^{UI}\pi^{UA}\tilde{b}_{UA,k}$. The statutory replacement rate is approximately 0.55 of the average net wage of previous employment, such that $\tilde{b}_{UA,k} \equiv 0.55 * w_k$. Entitlement length $\bar{s}$ is computed using the observed duration of the contribution period in the last employment spell and age-dependent rules before Hartz IV. Parameters $\{\lambda_k, \eta_{0,k}\}_{k=1}^{K}$ and $\{\alpha, \sigma, \pi^{UA}, \pi^{\chi}, \nu\}$ are structurally estimated. For methodological discussion of the prediction of parameters $\{A_k, \gamma_k\}_{k=1}^{K}$ and of the equilibrium solution for $\{w_k, u_k, \theta_k\}_{k=1}^{K}$ and κ see Launov and Wälde (2013).

		West			East		
		high	medium	low	high	medium	low
observed	$\pi(k)$	0.1989	0.4094	0.1688	0.0730	0.1202	0.0297
parameters	π_k^{UI}	0.3913	0.5068	0.3696	0.6757	0.7023	0.4412
policy	$\bar{s}_k$	15	11	11	12	12	13
parameters	$\tilde{b}_{UA,k}$	938	615	498	844	624	464
	λ_k	0.0055	0.0080	0.0124	0.0139	0.0203	0.0282
estimated and	$\eta_{0,k}$	0.0189	0.0224	0.0204	0.0268	0.0360	0.0314
predicted parameters	A_k	2155	1473	1368	2130	1588	1276
	γ_k	15633	14136	13916	27563	22464	8193
	w_k	1705	1118	905	1535	1134	843
equilibrium	θ_k	0.46	0.27	0.16	0.11	0.08	0.19
values	u_k	4.6%	7.4%	15.9%	15.1%	19.1%	22.1%
estimated	α	0.4203	π^{UA}	0.2398	ν	1.4438	
aggregate parameters	σ	0.7808	π^{χ}	0.9228			
aggregate	κ	0.0225		exogenous	ρ	2.4% p.a.	
equilibrium values	u	10.7%		parameters	β	0.5	

Table A.1 *Characteristics of the pre-reform steady state*

Table A.2 reports changes to benefits and entitlement as a consequence of Hartz IV. All values in this table are computed as described on page 19.

	West			East		
	high	medium	low	high	medium	low
ALG II as a share of UA	0.95	0.95	1.15	0.70	0.95	1.3
Entitlement cut (months)	3	1	1	1	2	2

Table A.2 *Specification of the Hartz IV reform*

- Second stage

The data for the second stage comprise stocks of matches, registered unemployed and vacancies at the regional level. The data source is the IAB (www.iab.de) reports. Figure A.1 plots the data aggregated to the country level for the illustrative purpose. Its upper part shows the evolution of unemployment and matches separately for short-term and long-term unemployed over the period from 2000 to 2009. Its lower part plots the dynamics of vacancies over the same period. Vertical axes display thousands of workers (for unemployment and matches) and thousands of idle jobs (for vacancies).

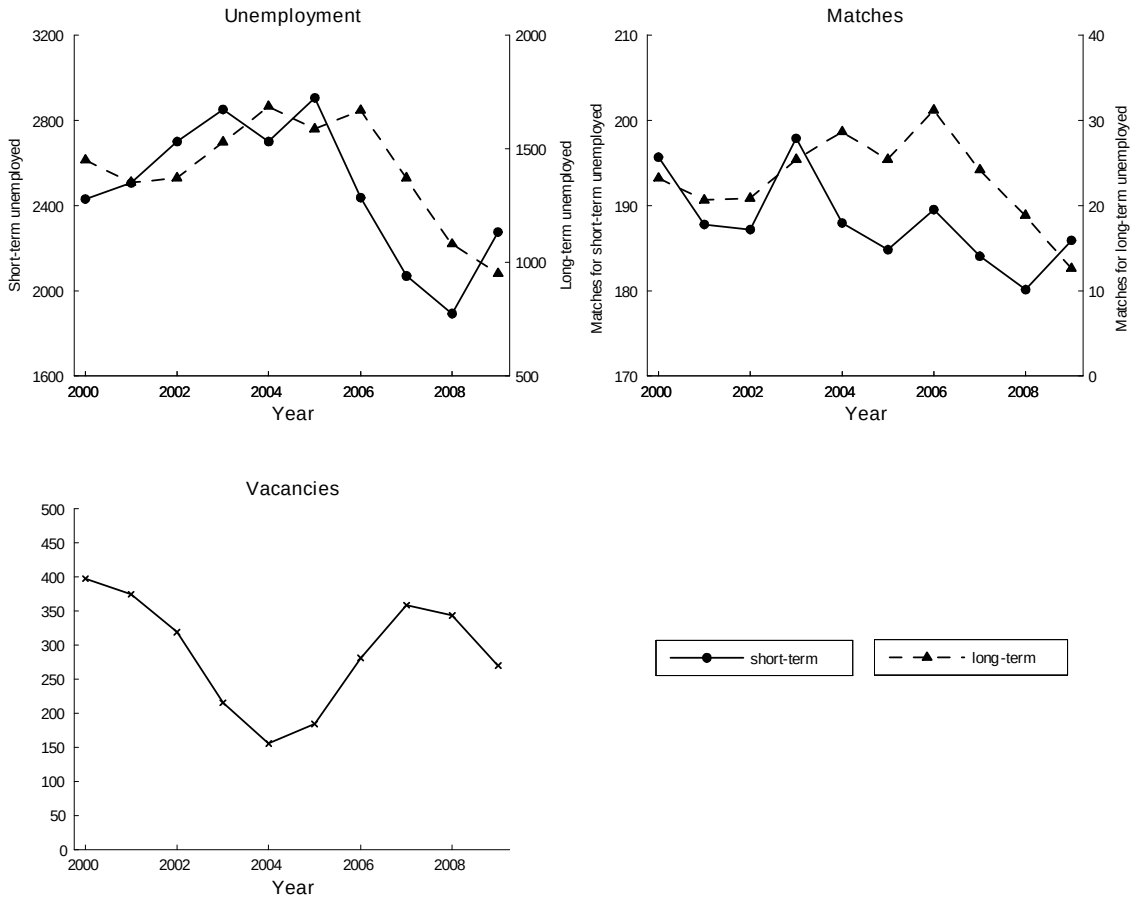

Figure A.1 Stocks of matches, unemployment and vacancies

These data define as short-term unemployed all individuals whose duration of unemployment does not exceed one year. The stock of vacancies used in our analysis contains only "normal" vacancies, i.e. regular jobs with contributions to social security system. These exclude marginal employment (e.g. that under arrangements of Hartz II), seasonal and irregular employment. Controls for structural breaks in unemployment statistics are explained in the main text. For further details on the data see Klinger and Rothe (2012), who use the same time series (at a monthly frequency)

A.3 Auxiliary regressions

Table A.3 reports estimation results on auxiliary regressions. Its upper and lower blocks deal with matches for short- and long-term unemployed, respectively. In both blocks columns (1)-(3) show the estimates from the specification without market-specific effects, (4)-(6) relate to specification with market-specific effects, and (7)-(9) report the estimates form the specification with market-specific effects and AR(1) process in the error term. Within each

Dependent variable: log-outflows from short-term unemployment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln U^{\text{short}}$	0.8211	0.8367	0.8420	0.3651	0.4462	0.4752	0.5958	0.6638	0.6444
	(0.0305)	(0.0285)	(0.0280)	(0.1011)	(0.1154)	(0.1144)	(0.0372)	(0.0383)	(0.0392)
$\ln V$	0.1685	0.1578	0.1522	0.1137	0.0996	0.1254	0.2374	0.1865	0.2031
	(0.0210)	(0.0202)	(0.0196)	(0.0495)	(0.0457)	(0.0460)	(0.0261)	(0.0241)	(0.0244)
Hartz-I&II	0.0143	0.0947	0.0923	0.0762	0.0983	0.1061	0.1068	0.1166	0.1237
	(0.0565)	(0.0548)	(0.0561)	(0.0243)	(0.0214)	(0.0211)	(0.0240)	(0.0200)	(0.0211)
Hartz-III	0.0558	0.0619	0.0598	0.0275	0.0279	0.0390	0.0767	0.0684	0.0744
	(0.0551)	(0.0532)	(0.0525)	(0.0226)	(0.0210)	(0.0226)	(0.0228)	(0.0191)	(0.0201)
Hartz-IV	0.0454	−0.0448	−0.0420	0.0312	−0.0004	−0.0151	−0.0347	−0.0541	−0.0617
	(0.0733)	(0.0775)	(0.0795)	(0.0325)	(0.0294)	(0.0300)	(0.0335)	(0.0282)	(0.0296)
d2005	−0.1378	−0.0583	−0.0612	−0.0686	−0.0490	−0.0406	−0.0382	−0.0310	−0.0231
	(0.0698)	(0.0725)	(0.0734)	(0.0278)	(0.0245)	(0.0237)	(0.0246)	(0.0205)	(0.0215)
d2009			−0.1965			−0.0681			−0.1051
			(0.0803)			(0.0513)			(0.0280)
t	0.0039	−0.0970	−0.0979	−0.0143	−0.0611	−0.0624	−0.0079	−0.0775	−0.0747
	(0.0197)	(0.0316)	(0.0317)	(0.0044)	(0.0153)	(0.0147)	(0.0078)	(0.0129)	(0.0135)
t^2		0.0102	0.0103		0.0051	0.0052		0.0074	0.0070
		(0.0029)	(0.0029)		(0.0020)	(0.0019)		(0.0012)	(0.0013)
$\iota_{i,s}$	no	no	no	yes	yes	yes	yes	yes	yes
φ_s							0.5178	0.5141	0.4960
							[1.0057]	[1.0044]	[1.0506]
R^2	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.96	0.96
obs.	117	117	130	117	117	130	117	117	130

Dependent variable: log-outflows from long-term unemployment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln U^{\text{long}}$	0.9021	0.9023	0.9017	0.9438	0.9475	0.9307	0.9168	0.9202	0.9065
	(0.0222)	(0.0221)	(0.0215)	(0.0532)	(0.0548)	(0.0552)	(0.0364)	(0.0378)	(0.0359)
$\ln V$	0.0539	0.0538	0.0537	0.0024	0.0012	0.0159	0.0407	0.0394	0.0500
	(0.0161)	(0.0157)	(0.0152)	(0.0318)	(0.0327)	(0.0294)	(0.0287)	(0.0290)	(0.0284)
Hartz-I&II	0.1632	0.1641	0.1633	0.1361	0.1370	0.1438	0.1510	0.1515	0.1563
	(0.0467)	(0.0485)	(0.0487)	(0.0354)	(0.0340)	(0.0343)	(0.0350)	(0.0352)	(0.0351)
Hartz-III	0.0666	0.0654	0.0666	0.0417	0.0379	0.0487	0.0601	0.0581	0.0654
	(0.0427)	(0.0485)	(0.0432)	(0.0280)	(0.0288)	(0.0277)	(0.0333)	(0.0339)	(0.0334)
Hartz-IV	0.0288	0.0169	0.0289	0.0785	0.0514	0.0652	0.0409	0.0249	0.0323
	(0.0737)	(0.1319)	(0.0734)	(0.0482)	(0.0455)	(0.0450)	(0.0603)	(0.0757)	(0.0607)
d2005	−0.0581	−0.0483	−0.0582	−0.0992	−0.0771	−0.0881	−0.0679	−0.0549	−0.0607
	(0.0621)	(0.1086)	(0.0613)	(0.0554)	(0.0545)	(0.0540)	(0.0472)	(0.0601)	(0.0475)
d2006	0.0904	0.0971	0.0905	0.0692	0.0840	0.0752	0.0856	0.0935	0.0895
	(0.0496)	(0.0760)	(0.0492)	(0.0440)	(0.0400)	(0.0420)	(0.0314)	(0.0386)	(0.0316)
d2009			−0.2435			−0.2453			−0.2444
			(0.0485)			(0.0274)			(0.0298)
t	−0.0222	−0.0254	−0.0222	−0.0208	−0.0282	−0.0213	−0.0212	−0.0269	−0.0217
	(0.0176)	(0.0289)	(0.0182)	(0.0094)	(0.0108)	0.0095	(0.0131)	(0.0209)	0.0132
t^2		0.0005			0.0012			0.0008	
		(0.0040)			(0.0011)			(0.0023)	
$\iota_{i,l}$	no	no	no	yes	yes	yes	yes	yes	yes
φ_l							0.3775	0.3778	0.3851
							[1.3327]	[1.3308]	[1.3374]
R^2	0.97	0.97	0.98	0.97	0.97	0.98	0.98	0.98	0.98
obs.	117	117	130	117	117	130	117	117	130

Table A.3 Auxiliary regressions for the real data

specification first column shows the results with linear trend, second column shows the results with quadratic trend and third column extends the time horizon adding the recession together with the corresponding dummy variable. Standard errors are in parenthesis. For columns (1)-(6) standard errors are bootstrapped, with 5000 replications. Values of the Durbin-Watson test statistic for significance of the autoregression coefficient in columns (7)-(9) are in square brackets.

From Table A.3 we can see that for the short-term unemployed quadratic trend is supported by all specifications. For the long-term unemployed only linear trend is supported and this support appears only in the specifications with market-specific effects. Significance of the linear trend is strong in the regressions without autoregressive term and weak in the regressions with autoregressive terms.[26] Regarding the estimates of the autoregression coefficient for short- and long term unemployed, despite the values of the Durbin-Watson statistic are low enough to support the existence of the autoregressive process, we lack the relevant critical values due to too small number of observations in the cross-section. Thus, from a purely formal point of view we can neither establish nor refute AR(1) process in the error term. For this reason we need to perform the sensitivity analysis. For the basis specification (see Table 1) we choose the regressions with quadratic term and AR(1) process in the errors for the short-term unemployed and with linear term and AR(1) process in the errors for the long-term unemployed workers. For the sensitivity analysis (see Table 3) we remove autoregressive term from the errors of both auxiliary regression equations. Finally, the last bit of the sensitivity analysis (see Table 5) extends each of these specifications adding the recession.

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[26] Linear trend is marginally significant at 10% level (p-value of 0.099) in column (9) and marginally insignificant at 10% level (p-value of 0.105) in column (7).

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