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Public Employment Agency Reform, Matching Efficiency, and German Unemployment*

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Abstract

Our paper aims at improving the understanding for the role of public employment agencies in job matching. We analyze the effects of the restructuring of the Federal Employment Agency in Germany (Hartz III labor market reform) for aggregate matching and unemployment. Based on two microeconomic datasets, we show that the market share of the Federal Employment Agency as job intermediary declined after the Hartz-reforms. We propose a macroeconomic model of the labor market with a private and a public search channel and fit the model to various dimensions of the data. We show that direct intermediation activities of the Federal Employment Agency did not contribute to the decline of unemployment in Germany. By contrast, improved activation of unemployed workers reduced unemployed by 0.7 percentage points.

JEL classification: E24, E00, E60

Keywords: Hartz reforms, search and matching, reform of employment agency

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1 Introduction

Registered unemployment in Germany declined from around 12 percent in 2005 to less than 6 percent. Prior to this unemployment decline, Germany's government implemented a sequence of major labor market reforms (the so called Hartz-reforms). While the reform of the unemployment benefit system (fourth package of reforms, Hartz IV) received a lot of attention in the macroeconomic literature,[1] research on the macroeconomic consequences of reform of the Federal Employment Agency (Hartz III) is relatively scarce.[2] Although there is substantial empirical evidence that aggregate matching efficiency increased in the aftermath of the Hartz-reforms (e.g. Fahr & Sunde 2009, Hertweck & Sigrist 2013, Klinger & Rothe 2012, Launov & Wälde 2016, Stops 2016, Gartner et al. 2019), it remains unclear whether and to what extent this increase of the matching efficiency is driven by a more successful job intermediation activity of the Federal Employment Agency. An answer to this question is important for future reforms and for other countries. As public employment agencies (PEA) offer vacancy referrals and job counseling in many OECD countries (e.g. Holzner & Watanabe 2020, 2021), it is crucial to understand how private and public job intermediation interact.

Our paper proposes a new model framework where both workers and firms decide endogenously whether they want to use one or two search channels (public and private). The calibrated version of our model is able to replicate the cyclical behavior of the PEA relative to the private market properly, namely the cyclicality of PEA's vacancy share and the share of matches intermediated via the PEA. Against this background, we use our quantitative model to match the structural shift of unemployment, PEA's vacancy share and PEA's matching share after the Hartz reforms. To do so, we provide new empirical evidence on the vacancy share and matching share over time based on the German Socioeconomic Panel (household survey) and the IAB Job Vacancy Survey (employer survey). While the German Federal Employment increased its market share of vacancies, the share of intermediated jobs dropped after the Hartz reform (both in the employer and household survey). Our quantitative structural exercise shows that the matching efficiency of the Federal Employment Agency actually declined after the Hartz-reforms. While the Hartz reforms did not improve the Federal Employment Agency's capability to intermediate jobs, the aggregate movements in the data are in line with an improved counseling/activation system that encouraged or forced workers to use private search channels more actively. Thus, the key macroeconomic policy message is that the reform of the Federal Employment Agency did not contribute to the decline of German unemployment in terms of better direct public job intermediation, but in terms of better activation policies. In more general terms, our paper shows that these activation policies generate a higher matching efficiency in aggregate matching

[1] See for example Krause & Uhlig (2012), Krebs & Scheffel (2013), Launov & Wälde (2013), Hochmuth et al. (2021), Hartung et al. (2018).

[2] For a notable exception see Launov & Wälde (2016). For institutional details on the Hartz reform package, in particular Hartz III, see Appendix A.

function estimations. Private search activity is stimulated by these measures. As private search is more effective than search via the PEA, this shift increases matching efficiency in a reduced-form matching function due to a compositional effect.

In our theoretical model, we assume a public and a private matching function. Unemployed workers have to register at the PEA in order to receive benefits. In addition, they endogenously choose whether to use the private channel or not. We assume that searching workers have to pay application costs, which are heterogeneous across workers. Firms' primary channel is the private market, as vacancies are typically immediately announced via firms' websites or informal channels (both private market channels). In addition, firms decide whether they want to register and post their vacancies at the PEA as well. Both firm channels are governed by vacancy free-entry conditions.[3] In the quantitative version of our model, firms post more vacancies in a boom. As the private search market is more congested in a boom, firms increase the share of vacancies that is also posted at the Federal Employment Agency. Nevertheless, the share of jobs that is intermediated via the PEA drops in a boom. Both privately and publicly intermediated vacancies increase in boom (the latter more) and as the private market is more efficient, the private market generates more additional matches.

The cyclical properties of our simulated model are in line with the observed patterns in the aggregate data. Based on newly compiled time series from the German Socioeconomic Panel (GSOEP) and the IAB-Job Vacancy Survey, we find that the vacancy share is procylical (i.e., it increases in booms), while the matching share is countercyclical. Given that we match the cyclicality properly, this puts us into a position to use our model for counterfactual structural exercises. Based on aggregated data from two microeconomic panels (one household survey and one firm survey), we show that the matching share fell by roughly 2 percentage points after the Hartz-reforms, while the vacancy share increased by roughly 2 percentage points. As these long-run changes may be driven by the the Hartz III-reform, other Hartz reform packages or other trends, we propose a matching exercise with three targets and three instruments. We match the decline of unemployment, the increase of the vacancy share, and the decline of the matching share by a move of the PEA's matching efficiency, activation policies and a positive match surplus shock (either triggered by an increase of aggregate productivity or a reduction of benefits). In this exercise, activation policies and the positive match surplus shock are key drivers for the decline of aggregate unemployment. We assume that the PEA makes it more attractive for unemployed workers to search on the private market. In practice, such a measure may be triggered by better counseling and/or sanctions. Quantitatively, it leads to a decline of unemployment of 0.7 percentage points of unemployment. This order

[3]Our model shows important similarities to Pissarides (1979) setup. However, there are also important differences. Workers' search decision is not sequential in the data (i.e. as in the data, using both channels at the same time is possible). We do not have fixed wages and can thereby analyze the implications of benefits shifts on wage bargaining outcomes. And we analyze the dynamic adjustment path of our labor market in response to business cycle shocks.

of magnitude is in line with Launov & Wälde (2016) who attribute this decline of unemployment to the Hartz III reform. In a nutshell: Our paper provides a theoretical foundation for the increase of aggregate matching efficiency and the decline of aggregate unemployment. We show that both changes were not triggered by a more effective public job intermediation, but they are in line with a more effective activation policy that leads to more private search.

While our conclusions are based on aggregate time series and aggregate modeling, they are completely in line with the institutional details and causal microeconometric evidence. Holzner & Watanabe (2020) and Holzner & Watanabe (2021) analyze the matching process of the PEA and the Hartz III-reform in two companion papers. They argue that vacancy referrals (i.e. public intermediation of jobs) were downgraded as part of the Hartz III-reform and the focus was shifted towards the private matching of jobs. This is complementary to our finding that the aggregate matching share of the Federal Employment Agency declined and that direct intermediation activity was unimportant for the decline of German unemployment. Holzner & Watanabe (2021) provide causal evidence that the Hartz III reform lead to a drop of vacancy referrals.

Our conclusion that activation and counseling policies were an important tool that lead to a substantial aggregate decline of unemployment complements a broad microeconomic literature. Schiprowski (2020) shows for example the importance of case workers for unemployment durations based on Swiss data. Hainmueller et al. (2016) exploit a pilot project. They show that local agencies (within the Federal Employment system in Germany) with a lower caseworker-to-clients ratio increased monitoring, imposed more sanctions and thereby reduced unemployment.

The economic policy lesson (for future reforms and other countries) of our paper is that the organizational restructuring of the Federal Employment Agency was successful because it devoted more resources to initiate more effective private job search. By contrast, improved public job intermediation was unimportant for the decline of German unemployment. The market share of the Federal Employment Agency is very small (less than 10 percent). We show in counterfactual exercises that a substantial decline of unemployment due to better public intermediation would require implausibly large increases of public matching efficiency, which would lead to market shares that are not in line with the data. In addition, our reduced form matching function estimations provide no evidence in favor of a better intermediation of jobs via the agency.

The rest of the paper proceeds as follows. Section 2 shows empirical facts on the role of the Federal Employment Agency in the matching market. Section 2 derives a new theoretical model. Section 3 presents the calibration strategy. Section 4 shows results and counterfactual exercises. Section 5 briefly concludes.

2 Empirical Facts

This section establishes new empirical facts for the role of the Federal Employment Agency in job intermediation and matching before and after the Hartz

III labor market reform. We show time series for the share of vacancies that is registered at the Federal Employment Agency (vacancy share, henceforth) and the share of matches that is intermediated via the Federal Employment Agency (matching share, henceforth). We calculate the vacancy share based on the IAB Vacancy Survey, which is an annual representative cross-sectional firm survey. We calculate the matching share based the German Socioeconomic Panel (GSOEP) (Goebel et al. 2019), which is an annual household survey. We also show results for the matching share based on the IAB Vacancy Survey in the Appendix. Both sources yield very similar developments over time.

For calculating the vacancy share, we use the questions in the IAB Job Vacancy Survey how many vacancies an establishment had and how many of these were reported to the agency. Figure 1 shows the aggregated vacancy share from 1993 to 2018. Two facts stand out: First, the average vacancy share is 37 percent. Thus, on average about every third vacancy is reported at the Federal Employment Agency. Second, the vacancy share increased after the Hartz III reform. The average value after 2004 is about 2 percentage points higher than before the reform.

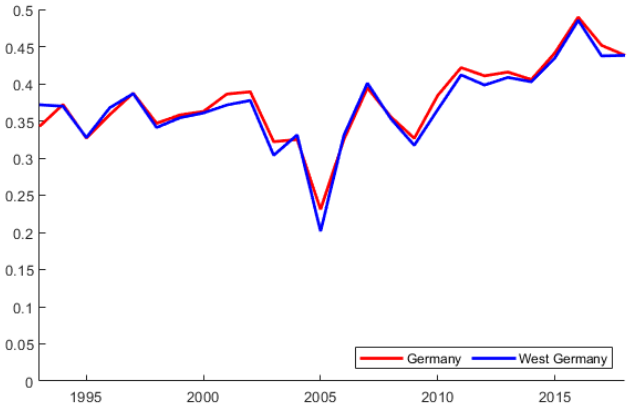

Figure 1: Vacancy Share based on the IAB Vacancy Survey

For calculating the matching share we use the question in the GSOEP how an individual found out about her new job. Figure 2 shows the matching share from 1993 to 2018 based on the GSOEP. Two facts stand out: First, the average matching share was never above 16 percent in any year. On average, it was less than 10 percent. Second, in contrast to the vacancy share, the matching share shows a downward trend after the Hartz III reform. It fell by roughly 2 percentage points.[4] For comparability reasons, we have shown Figures 1 and 2 for the same time episode. Figure 2 may lead to the impression that the

[4]As can be seen in Figure A3, the decrease in the matching share remains when only observations with an ending unemployment spell at the time the new position starts are included.

Figure 2: Matching Share. The figure shows the matching share based on the GSOEP. More details can be found in section 9.1.

matching share is subject to a long-lasting downward trend. Figure A1 in the Appendix shows that this impression is due to the observation period. For a longer time episode, no clear-cut time trend of matching shares for (West) Germany is visible.

Table 1 shows the matching shares for low-, medium-, and high-skilled workers before (1993-2003) and after the Hartz III-reform based on the GSOEP (2004-2018). The Federal Employment Agency has a larger market share for low- and medium-skilled workers. However, there was a similarly large decline of the matching share for all qualification groups. Thus, it is unlikely that the average decline of the matching share is driven by a compositional effect across skill groups (e.g. by the agency being specialized on a certain segment, which was a larger part of overall unemployed after the reform). Therefore, we abstain from modelling different ex-ante skills in our theoretical framework.[5]

Finally, we analyze the business cycle properties of vacancy and matching share. Figure 3 shows that the vacancy share comoves negatively with unemployment, while the matching share comoves positively with unemployment. The correlation between the vacancy share and unemployment is -0.74. In different words, in times of labor market booms (associated with lower unemployment) firms post a larger fraction of vacancies at the Federal Employment Agency. This is consistent with Bossler et al. (2018) and Lochner et al. (2020) who find that the number of recruitment channels used by firms is procyclical. The correlation between the matching share and unemployment is roughly 0.66.

[5]From Table 9.2, it can be seen that we also find no evidence that the matching share increased for individuals with a loose connection to the labor market. Furthermore, the result of a lower average probability that a match was generated by the agency after the reform remains even after controlling for individual characteristics (see Table A3).

Table 1: Matching Shares according to Qualification

Matching Share	pre Reform	post Reform	Difference
Germany			
Low	0.111	0.082	-0.019
Medium	0.120	0.097	-0.023
High	0.050	0.033	-0.017
West Germany			
Low	0.095	0.078	-0.017
Medium	0.106	0.089	-0.017
High	0.048	0.031	-0.017

Calculations are based on GSOEP. Low-skilled workers are those whose employment typically does not require formal training. Medium-skilled and high-skilled workers are those who are employed in a position that typically requires vocational training and a college or university degree respectively.The table shows the average matching share before and after the year 2004. Individuals are weighted with the cross-sectional weights.

Thus, although more vacancies are posted at the Federal Employment Agency in booms, the matching share falls. As we will show below, our model is able to replicate the procycliality of the vacancy share and the countercyclicality of the matching share.

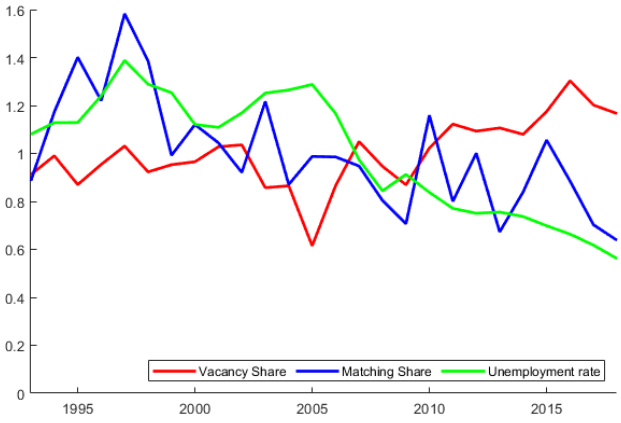

Figure 3: Vacancy share, matching share and unemployment over time. All variables are normalized such that they are one on average.

3 Model

We propose a model that allows for search via the public agency, denoted by a, and the private sector, denoted by p. As in the standard search and matching model (e.g. Pissarides 2000, Ch.1), firms post vacancies and unemployed workers search for a job. On top of this, in our model firms and unemployed workers choose whether they want to use both search channels (private and agency) or not. We assume that unemployed workers always search via the agency, as formal registration requirements force them to do so. In addition, they choose endogenously whether to use the private market. By contrast, we assume that firms automatically use the private market. Creating a new vacancy at the firm level is typically associated with activities that involve the private market (e.g. announcement via informal channels, posting on the website). In contrast to workers, firms do not have to use the PEA. However, they can also use the agency as a second channel for finding a worker. Using a second search channel is associated with costs, but it increases the probability of getting in contact with firms or workers respectively.

3.1 Search Markets

We assume that the agency establishes contacts between workers and firms with a constant returns to scale contact function:

$$c_t^a = \psi_t^a s_t^{1-\alpha_a} f_t^{\alpha_a} \tag{1}$$

where c_t^a stands for the contacts established by the agency and ψ_t^a is the agency's matching efficiency. We denote s_t as the number of searching workers that use the agency (which are by assumption all workers). f_t is the number vacancies that are reported by firms at the agency. Dividing the number of agency contacts c_t^a by the number of unemployed s_t gives the contact-finding rate p_t^a of the public search sector.

$$p_t^a = \psi_t^a \tau_t^{\alpha_a}, \tag{2}$$

where $\tau_t = f_t/s_t$ is the tightness of the agency's search market.

Note that firms typically do not report all of their vacancies, while all unemployed are assumed to search via the agency (supported by empirical evidence). Thus, τ_t is smaller than the tightness of the overall labor market $\Theta_t = v_t/s_t$, where v_t is the total number of vacancies in the economy.

A firm gets in contact with a suitable candidate for a reported vacancy with rate

$$q_t^a = \psi_t^a \tau_t^{\alpha_a - 1}. \tag{3}$$

In addition to the agency, there is the private search market, consisting of private contacts, private websites, or private agencies. We also assume a constant returns to scale contact function for the private market:

$$c_t^p = \psi_t^p u_t^{1-\alpha_p} v_t^{\alpha_p}. \tag{4}$$

The number of privately searching unemployed is given by u_t. Thus, we can express the contact-finding rate of the private sector ($p_t^p = c_t^p/u_t$) as

$$p_t^p = \psi_t^p \theta_t^{\alpha_p}, \tag{5}$$

where θ_t is the private sector market tightness ($\theta_t = v_t/u_t$). Similarly, the worker-contact rate for firms is

$$q_t^p = \psi_t^p \theta_t^{\alpha_p - 1}. \tag{6}$$

3.2 Search Decision: Households

Households always search via the agency. This is motivated by empirical facts[6] and by formal registration requirements for unemployed workers by the agency. In addition, households may be using a private search channel. Using the private search channel is subject to idiosyncratic costs e_{it}, which is drawn from a stable density function $h(e_t)$ and which is iid across workers and time. Thus, only those households search privately where the expected return from private search is larger than the expected costs. This means that they are indifferent at the cutoff point $\tilde{e}_t$.

$$\tilde{e}_t = b - b^r + \bar{p}_t^p \beta E_t(W_{t+1} - U_{t+1}), \tag{7}$$

where $\bar{p}_t^p$ is the extra probability of finding a job when using the private market on top of the agency. We will show in the Appendix that $\bar{p}_t^p = (p_t^p - p_t^p p_t^a - \iota_t^p g_t q_t^q p_t^p)$. The household present values for employment W_t and unemployment U_t are defined in the bargaining section. If the agency sanctions unemployed workers who do not search privately, it pays those workers reduced benefits b^r, such that $b > b^r$ holds. It can be seen from equation (7) that this increases the cutoff for the search cost. We use η to express the difference between b and b^r, thus $\eta = b - b^r \geq 0$. The parameter η will be used in our quantitative exercise to analyze the implications of sanctions/monitoring by the PEA.

Based on the cutoff point, we can derive the share of private job seekers that will choose this second channel.

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h(e_t)\, de_t, \tag{8}$$

where h is the stable density function of the underlying disutility distribution. Finally, the conditioned expected value of search costs is given by

$$\widehat{e}_t = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h(e_t)\, de_t}{H(\tilde{e}_t)} \tag{9}$$

[6] Franz (2013, p.231) shows for Germany that 97% of unemployed workers used the Federal Employment Agency for their job search.

3.3 Search Decision: Firms

Firms' primary search channel is the private search market. We assume that they post all of their vacancies at the private market. The underlying idea is that once a vacancy is created, private channels are automatically used (e.g. by posting the advertising on the firm website, or spreading the word within the firm).

In addition, firms may choose to post a certain fraction g_t of these vacancies at the agency as well. When using this channel on top of the private market, firms have to pay an additional fixed cost (e.g. because somebody has to report this vacancy to the computer system of the PEA).

The share of agency relative to private is defined as

$$g_t = \frac{f_t}{v_t}. \tag{10}$$

This share is the result of the decisions of the firms in this section.

Firms maximize intertemporal expected profits. Period-by-period profits are the difference between productivity, a_t, and wages, w_t, multiplied with the number of workers, n_t, minus the overall costs for vacancy posting, which consists of private (κ^p) and agency vacany posting costs (κ^a).

$$\Pi_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left[(a_t - w_t)\, n_t - v_t^p (\kappa^p + \kappa^a g_t) \right] \tag{11}$$

subject to the constraint:

$$n_{t+1} = (1-\phi) n_t + v_t^p q_t^p (1 - \iota_t^p p_t^a) + v_t^p g_t q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t) \tag{12}$$

The maximization with respect to n_{t+1}, v_t^p, and g_t yields two job-creation conditions (see Appendix for derivations)

$$\frac{\kappa^p}{q_t^p (1 - \iota_t^p p_t^a)} = \beta E_t J_{t+1} \tag{13}$$

$$\frac{\kappa^p + g_t \kappa^a}{q_t} = \beta E_t J_{t+1} \tag{14}$$

where q_t is the average worker-finding rate and J_t is the value of a matched job:

$$J_t = a_t - w_t + \beta E_t \left(1 - \phi\right) J_{t+1}, \tag{15}$$

By combining the previous three equations, we can rewrite the above two equations as standard job-creation conditions.

$$\begin{aligned} \frac{\kappa^a}{q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)} =& E_t \beta ((a_{t+1} - w_{t+1}) \\ &+ (1-\phi) \frac{\kappa^a}{q_{t+1}^a (1 - q_{t+1}^p - \iota_{t+1}^a p_{t+1}^p \xi_{t+1})}) \end{aligned} \tag{16}$$

$$\frac{\kappa^p}{q_t^p(1-\iota_t^p p_t^a)} = E_t\beta((a_{t+1}-w_{t+1}) + (1-\phi)\frac{\kappa^p}{q_{t+1}^p(1-\iota_{t+1}^p p_{t+1}^a)}) \tag{17}$$

These are the two job-creation condition for the two types of vacancies that exist in the model. The only differences to the standard job-creation condition are the adjustments in the denominators in both equations.

3.4 Wage Bargaining

Once workers and firms are matched, they produce the same good (independently of the contact channel). The present value of employment is

$$W_t = w_t + \beta\left((1-\phi) + \phi p_t)\right) E_t W_{t+1} + \beta\phi(1-p_t)E_t U_{t+1}, \tag{18}$$

where U_t is the average expected present Value of unemployment. Given that some of the unemployed are searching privately and others only use the agency, two values of unemployment in period t can be distinguished. If only the agency is used, no private search costs are paid. However, there is also a lower probability of being employed in the next period. The corresponding value of unemployment is given by

$$U_t^a = b^r + \beta(p_t^a(1-\iota_t^a q_t^p)E_t W_{t+1} + \beta(1-p_t^a(1-\iota_t^a q_t^p)E_t U_{t+1}, \tag{19}$$

where b^r are unemployment benefits. Since this worker does not search privately she gets the reduced benefits b^r. This can be lower than the normal benefits b. A worker who uses the private sector has a higher probability of finding a suitable job, but she has to bear additional search costs. As shown in the appendix, the additional probability is $p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)$. So the value of unemployment for a private searcher i in period t is:

$$\begin{aligned} U_{it}^p = b - e_{it} + \beta(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t))E_t W_{t+1} \\ +\beta(1-(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)))E_t U_{t+1} \end{aligned} \tag{20}$$

The disutility costs of searching privately for worker i at period t are given by e_{it}. This search costs are drawn from a stable idiosyncratic distribution in the beginning of each period. Again, it is taken into account that a job seeker who uses both search channels may receive two offers. In addition, there is the possibility that an unemployed person finds a suitable job, but the firm fills the vacancy with a candidate it has found through the other search channel. This possibility is taken into account by the adjustments in equations (19) and (20). The average expected present value of unemployment can be written as:

$$U_t = \xi_t b + (1-\xi)b^r - \xi_t\widehat{e}_t + \beta p_t E_t W_{t+1} + \beta(1-p_t)E_t U_{t+1}, \tag{21}$$

where $\widehat{e}_t$ is the conditional expected value of the extra costs for private search e_{it}. As shown in the appendix, p_t is the aggregate job-finding-rate.

We assume that wages are determined by Nash bargaining. At the beginning of period t, employers and employees negotiate the wage for period t. The workers matched in period $t-1$ also take part in this negotiation. Given that the workers here do not yet know what search costs they would draw if the negotiations fail, the conditioned expectation value of the search costs in period t $\widehat{e}_t$ weighted with ξ_t applies to each of them. The Nash bargaining problem looks as follows:

$$w_t \in argmax \left(W_t - U_t\right)^{\gamma} \left(J_t\right)^{1-\gamma} \tag{22}$$

where γ is the bargaining bower of the workers. Maximization with respect to w_t yields:

$$\gamma J_t = (1-\gamma)(W_t - U_t) \tag{23}$$

3.5 Aggregation

Each contact is suitable to become a match but given that a share of unemployed workers ξ_t uses both the public and the private search channel their total probability of having a job in the next period is a combination of the two Poisson arrival rates p_t^p and p_t^a. Some workers may receive two job offers, but can only accept one. The same holds true for reported vacancies. With probability $q_t^a q_t^p$ a firm has two suitable candidates for a reported vacancy. Since we interpret a vacancy as an advertisement for a specific job, one of the two suitable candidates is not employed by the firm. These duplications are also deducted in the equation for the number of matches. The effective number of matches m_t (without superscript for a specific search channel) is:

$$m_t = c_t^a + c_t^p - p_t^p p_t^a u_t - q_t^p q_t^a f_t, \tag{24}$$

Given m_t we can now define the aggregate job- and worker-finding rates as:

$$p_t = m_t / s_t \tag{25}$$

$$q_t = m_t / v_t \tag{26}$$

The next step is to find the matches created by each sector. In order to do this, we need to make an assumption about how the double matches described above will be divided between two the sectors. ι_t^p is the share of double matches that are deducted from the private matches. In the following we assume that this proportion is equal to the ratio of the private contacts according to equation (4) and the sum of the contacts from the equations (4) and (1).[7] Now we can write the number of matches in each sector as

$$m_t^a = c_t^a - \iota_t^a (p_t^p p_t^a u_t + q_t^p q_t^a f_t), \tag{27}$$

[7] Thus: $\iota_t^p = \frac{c_t^p}{c_t^a + c_t^p}$ and $\iota_t^a = 1 - \iota_t^b$.

$$m_t^p = c_t^p - \iota_t^p(p_t^p p_t^a u_t + q_t^p q_t^a f_t). \tag{28}$$

Now we can define the matching share of the agency as

$$Q_t = \frac{m_t^a}{m_t} \tag{29}$$

Given our assumption on how double matches are split between sectors, the matching share can be rewritten as

$$Q_t = \frac{c_t^a}{c_t^a + c_t^p} \tag{30}$$

The last aggregate variable to be considered is the employment level n_t. Normalizing the overall number of workers to one, one can summarize the employment dynamics with the following equations:

$$n_{t+1} = (1-\phi)n_t + m_t \tag{31}$$

$$s_t = 1 - n_{t-1} + \phi n_{t-1} \tag{32}$$

$$u_t = \xi_t s_t, \tag{33}$$

$$s_t^u = 1 - n_t \tag{34}$$

where ϕ is the exogenous separation rate. Equations (31) is the law of motion for employment. We assume that newly unemployed workers can be immediately rehired. Thus equation (32) gives the number of job seekers. Given the share of active searching job seekers ξ_t, which is determined in the next section, their level is determined by equation (33). The number of unemployed is given by (34).

4 Calibration Strategy

We calibrate our model at the monthly frequency. Therefore, we choose a discount factor $\beta = 0.99^{\frac{1}{3}}$. We normalize aggregate productivity to a value of $a = 1$. We assume that workers' bargaining power is $\gamma = 0.5$. In line with German institutions, unemployment benefits are set to $b = 0.6$.

For the initial steady state (before the Hartz reforms), we target the steady state unemployment rate, s^u, the share of vacancies posted by the agency, g, the share of matches created by the agency, Q, the economy-wide job-finding rate, p, the agency's market tightness, τ^u, and the share of workers that search privately, ξ (see Table 2).[8] To reach these targets, we use the private and agency's steady states value for the matching efficiencies, ψ^p, and ψ^a, the vacancy posting costs in both sectors, κ^a and κ^p, the separation rate ϕ, and the mean of the distribution for private search costs, μ (see Table 3), assuming a logistic distribution.

[8] τ^u corresponds to the reported vacancies divided by the number of unemployed.

[9] We use the quarterly job finding rate from Gartner et al. (2012) combined with the equation to convert it to monthly rates from Blanchard & Galí (2010)

Table 2: Targets

Target		Value	Source
α	Elasticity of jfr	0.30	estimated
α_a^m	Elasticity of jfr^a	0.12	estimated
σ_g/σ_s	Relative std. dev. of g	1.77	IAB JVS
τ^u	Public tightness	0.09	IAB JVS
g	Vacancy share	0.36	IAB JVS
Q	Matching share	0.09	GSOEP
ξ	Private searchers	0.68	GSOEP
s^u	Unemployment	0.09	BA
p	Job finding rate	0.10	Literature[9]

Table 3: Parameters

Parameter	Symbol	Value
Elasticity of p^p w.r.t. θ	α_p	0.09
Elasticity of p^a w.r.t. τ	α_a	0.09
Location parameter cost distribution	μ	0.02
Scale parameter cost distribution	σ	0.29
Separation rate	ϕ	0.01
Vacancy posting costs	κ^p	0.8
Vacancy posting costs	κ^a	0.12
Matching efficiency	ψ^p	0.16
Matching efficiency	ψ^a	0.01

To discipline the reaction of our quantitative model to aggregate shocks and policy changes, we target the volatility of the share of vacancies that is intermediated via the agency and the curvature of the matching function. We set the standard deviation of the search cost distribution, σ, such that our model replicates the relative standard deviation of g to s^u. In addition, we ensure that our simulated model generates the same elasticity of the aggregate and agency's job-finding rate with respect to the relevant market tightness.[10] For this purpose, we set α_a and α_p.[11] For the stochastic simulation we use an AR(1) process for productivity. We set the correlation coefficient to 0.95 and the standard deviation to 0.0044 which we took from Kohlbrecher et al. (2016).

We propose a matching exercise to quantify the steady state aggregate unemployment effects of different policy reforms. For this purpose, we use three

[10] Since we do not have the share of privately searching unemployed for the full time period, we cannot estimate the private elasticity.

[11] The two elasticities are estimated by regressing the corresponding job-finding rate on the relevant market tightness. The job-finding rate of the agency is constructed by multiplying the aggregate job-finding rate with the matching share of the agency. The stated values for the elasticities are estimated with robust standard errors. They are significant on the 1% (α) and 5% (α_a^m) level, where α is the estimated aggregated coefficient. α_a^m is the estimated coefficient for the agency.

policy changes. First, we allow for a different matching efficiency of the PEA, $\Delta\psi^a$. The restructuring of the Federal Employment may have increased its ability to intermediate jobs directly. In our model, a higher public matching efficiency reduces unemployment, as it is easier for unemployed workers to match via this channel. In addition, a more efficient public search channel increases both the PEA's vacancy and matching share. Second, we use activation policies in our model. In practice, the Federal Employment Agency may have improved its counseling for unemployed workers such that they apply more frequently at private employers and/or it may have punished workers that do not fulfil certain search requirements. In our model, we assume that the use of the private search channel is made more attractive, using the parameter η. Thus, a larger fraction of unemployed workers uses the private market on top of the PEA. This leads to a drop of unemployment and a reduction of PEA's vacancy share and matching shares. Third, we allow for a different joint match surplus, $a - b$. The higher joint surplus may either by triggered by a reduction of unemployment benefits or an increase of productivity. The Hartz IV reform reduced unemployment benefits for long-term unemployed. In addition, Germany faced a substantial business cycle upswing and increase of net exports in the aftermath of the Hartz reforms. Both developments lead to a higher joint match surplus in the context of our model. A higher joint match surplus increases the incentives on both sides of the market to use a second search channel. Workers are more likely to use the private search channels and firms are more likely to post vacancies at the PEA. The latter effect leads to an increase of PEA's vacancy share, while the former reduces PEA's matching share. More details on this mechanism will be provided in the next section in the context of a business cycle shock.

Table 4: Qualitative responses

	ψ^a	η	$a-b$
Unemployment	-	-	-
Vacancy Share	+	-	+
Matching Share	+	-	-

As Table 4 shows, all three policy exercises lead to a reduction of unemployment. However, their effects on the vacancy and matching shares show different signs. This allows us to do a matching exercise with three targets (unemployment, vacancy share, and matching share) and three policy interventions (PEA's matching efficiency, activation policies, and increase of matching surplus). Before we proceed to this exercise in Section 5.2, we show the business cycle behavior of our model to a positive surplus shocks.

5 Results

5.1 Model Mechanisms

We start by illustrating the dynamic model reaction of our calibrated model. This allows us to show that our model generates business cycle reactions to an aggregate productivity shocks that are in line with the presented facts in Section 2. In addition, it allows us to convey an intuition for the underlying model mechanism.

Figure 4 shows impulse response functions in response to a positive aggregate productivity shock (i.e. a positive surplus shock). As usual in search and matching model, this shock increases firms' vacancy posting, increases workers' job-finding rate and thereby reduces unemployment.

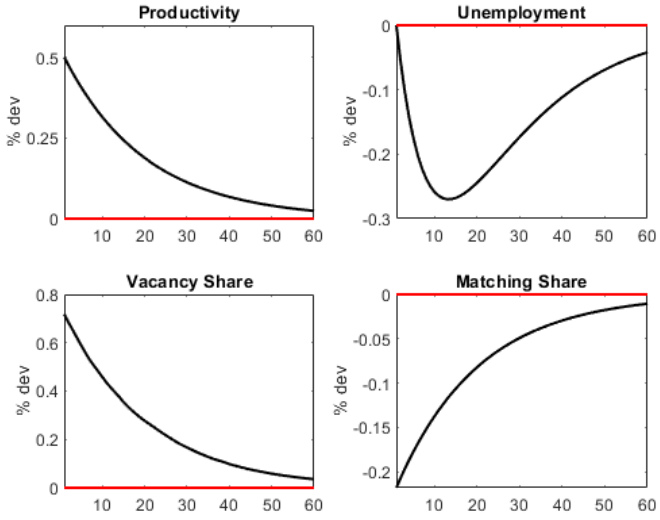

Figure 4: Response to a productivity shock

In addition to the standard aggregate reaction, our model provides a detailed description of the reaction of private and public matching markets. With larger aggregate productivity, expected profits from posting a vacancy increase. Thus, firms start posting more private vacancies, which increases market tightness in the private market. This leads to a more congested private search market, which rises the average hiring costs in this segment. As a consequence, firms also start posting a larger fraction of their vacancies at the public employment agency. This increases the agency's vacancy share. Nevertheless, the agency's matching share falls. More households have an incentive to use the private search market in a boom as the expected returns are larger than their idiosyncratic search costs. This increases privately intermediated matches and thereby reduces the PEA's matching share.

It is worth emphasizing that our model is able to replicate the cyclicality of the vacancy share and the matching share from the data (see Section 2). While firms post a larger fraction of their vacancies at the Federal Employment Agency in booms, the agency's intermediation share falls in booms. This is a useful sanity check when using our model for analyzing structural labor market reforms where joint match surplus shocks also play a role.

5.2 Disentangling the Reform Effects

In our matching exercise, we target three outcome variables (decline of unemployment, increase of vacancy share, and decline of matching share) with three policies (changed public matching efficiency, activation policies, and different surplus). Table 5 shows the results of our matching exercise. Jointly the three policy interventions match the three targets exactly. Table 5 also shows the effects of each individual policy exercise (i.e. without the other policy exercises being active). Note that the sum of these individual exercises does not necessarily add up to the joint effect of all three exercises due to the nonlinear deterministic solution method.

Table 5: Policy responses with sanctions

	$\Delta\psi^a$	$\Delta\eta$	$\Delta(a-b)$	Joint Effects
Unemployment	0.01	-0.68	-2.11	-2.35
Vacancy Share	-2.57	-0.71	6.56	2.36
Matching Share	-0.63	-0.54	-1.19	-1.98

According to our matching exercise in Table 5, the matching efficiency of the Federal Employment Agency fell after the Hartz reforms.[12] Several aspects are worth emphasizing in this context. First, keep in mind that the Federal Employment Agency's matching share fell by 2 percentage points after the Hartz III reform. This limits the possibility for the public matching efficiency to be a key driver for the reduction of unemployment. Second, the reduced PEA's matching efficiency is in line with Holzner & Watanabe (2021) who argue that vacancy referrals (i.e. public intermediation of jobs) were downgraded as part of the Hartz III-reform and the focus was shifted towards the private matching of jobs. They also provide causal microeconometric evidence (using the time path of the Hartz III reforms in different regions) that the Hartz III reform lead to a drop of vacancy referrals. Third, in Table A2 the Appendix, we show simple reduced-form matching function estimations for the Federal Employment Agency's matching function. These estimations also provide no evidence for a potential increase of public matching efficiency. The estimated matching efficiency after the Hartz III reform is even negative. However, it is statistically insignificant at conventional levels.

In our matching exercise, activation policies deliver a substantial reduction

[12] $\Delta\psi^a/\psi_0^a = -6.67\%$

of unemployment of around -0.7 percentage points.[13] With activation policies, the PEA uses stick and carrot to activate unemployed's private search activities. This leads to a decline of unemployment, without increasing matching efficiency (which would not be in line with the data). The aggregate reduction of unemployment is in line with Launov & Wälde (2016) who argue that the Hartz III labor market reform reduced aggregate unemployment by -0.7 to -0.9 percentage points. In addition to Launov & Wälde (2016), we provide further evidence on the underlying channel. It is not direct intermediation activities of the PEA that reduced unemployment, as this would require a substantial increase of the agency's matching share. By contrast, our results suggest that activation policies played a key role for the reduction of aggregate unemployment. Our finding complements a broad microeconomic literature from a macroeconomic perspective. Schiprowski (2020) shows for example the importance of case workers for unemployment durations based on Swiss data. Hainmueller et al. (2016) exploit a pilot project. They show that local agencies (with the Federal Employment system in Germany) with a lower caseworker-to-clients ratio increased monitoring, imposed more sanctions and thereby reduced unemployment.

Finally, we show that the increase of the joint surplus from work/production[14] played an even more important role for the reduction of aggregate unemployment than activation policies by the PEA. Note that the increased joint surplus increased the PEA's vacancy share, as firms now post more vacancies at the agency due to the labor market boom. However, the increase of the joint surplus alone would increase the vacancy share quantitatively too much. This requires other policies (as the previously shown reduction of the agency's matching efficiency and activation policies) that lead to a reduction of the vacancy share.

It is worthwhile reemphasizing that it makes no difference for our surplus matching exercise whether the higher surplus is generated by a reduction of benefits and/or an increase of aggregate productivity (as proxy for the business cycle and the strong increase of German net exports). As the main focus of our paper is the Hartz III-reform, we remain agnostic on the underlying channel. Instead, we refer to a large literature that discusses the replacement rate reduction due to the Hartz IV reform and its macroeconomic implications (e.g. Krause & Uhlig (2012), Krebs & Scheffel (2013), Launov & Wälde (2013), Hochmuth et al. (2021), Hartung et al. (2018), Klein & Stefan (forthcoming), Carrillo-Tudela et al. (2021)).

5.3 Activation Policies and Matching Efficiency

To illustrate the interaction between activation policies and aggregate matching efficiency, we simulate our model economy with a series of aggregate productivity shocks. Figure 5 shows how the model economy reacts in the vacancy-unemployment space to the same set of aggregate shocks without (in blue) and

[13] The result is generated by sanctions of $\Delta\eta = 0.05$.
[14] $\Delta(a - b) = 0.220$

with activation policies in place (in red). It is visible that the aggregate Beveridge Curve shifts to the left (illustrated by the fitted Beveridge Curves in green and in black). This patterns is completely in line with the actual leftward shift of the actual Beveridge Curve in Germany in the aftermath of the Hartz reforms.

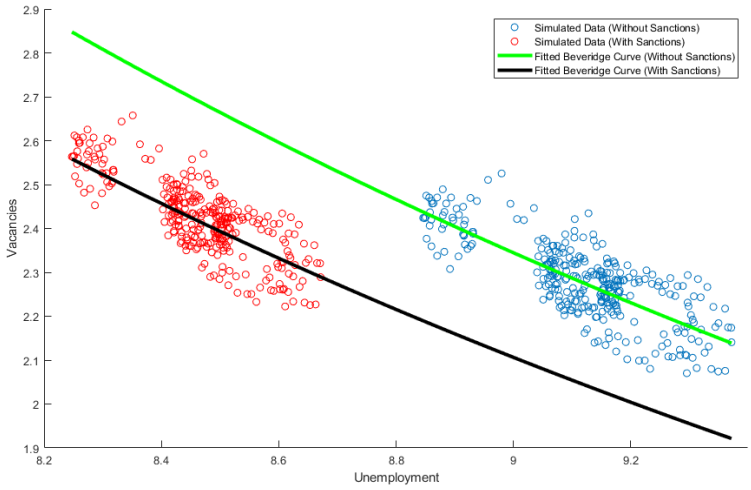

Figure 5: Beveridge Curve

Through the lens of a standard search and matching function a leftward shift of the Beveridge Curve is typically interpreted as an increase of aggregate matching efficiency. In our model with two search channels, activation policies lead to a stronger additional use of the (more efficient) private search channel by workers and thereby trigger this leftward shift.

Another way to illustrate this finding is to rely on direct matching function calculations based on the simulation outcomes. Matching efficiency estimations are a common tool to analyze the implications of labor market reforms (see for example Fahr & Sunde (2009), Hertweck & Sigrist (2013), Klinger & Rothe (2012), Gartner et al. (2019)). Typically applied econometricians look at the data through the lens of one (single) aggregate matching function. So far, our paper has shown the interaction between PEA and the private market, both from a theoretical and empirical perspective. Therefore, we analyze how the estimated aggregate (reduced-form) matching efficiency is affected by this interaction. For this purpose, we look at the simulation outcomes (generated by our model) through the lens of a standard Cobb-Douglas constant returns aggregate matching function:

$$log\, p_t = log\, \Psi + \alpha\, log\, \Theta_t^u \tag{35}$$

and back out the aggregate matching efficiency Ψ. We know the aggregate job-finding-rate p_t and the aggregate tightness Θ_t^u in the pre- and post-reform steady state.[15] By plugging in the estimated value of the aggregate elasticity of the job-finding-rate with respect to the tightness $\alpha = 0.302$, we obtain an equation with one unknown that can be solved for the aggregate efficiency in both steady states.

Table 6: Policy response of the aggregate Efficiency

	$\Delta\psi^a$	η	$\Delta(a-b)$	Joint Effects
Ψ	-0.25	3.29	-0.42	0.98

Table 6 shows that aggregate matching efficiency in our model simulation increased by 1 percent after the Hartz reforms.[16] Note that this happens, although private matching efficiency in our model remains unaffected and public matching efficiency even falls. Table 6 decomposes this effect and shows that the other two policy interventions lead to a small decline of aggregate matching efficiency.

This section has shown that activation policies by the PEA shift the Beveridge curve to the left. In addition, through the lens of an aggregate matching function it appears as if aggregate matching efficiency increases. While aggregate matching functions are a useful tool to analyze the aggregate efficiency of labor market matching, our paper sounds a cautionary note on matching function estimations as a tool to directly determine the effects of certain labor market reforms. Once the labor market has a more complex structure (as the interaction of public and private sector matching in our model), aggregate matching efficiency estimations may capture compositional changes. This is the case in our counterfactual exercise where the three policy exercises shift the economy towards more privately intermediated matching (which is on done with a higher matching efficiency). Therefore, it is important to analyze the underlying structural forces at work.

5.4 Further Robustness Checks

One of the key contribution of our paper is the quantification of the direct and indirect effects of the institutional reform of the Federal Employment Agency. Based on our matching exercise, we only found negligible direct effects of the Federal Employment Agency in its role as intermediary.

To check for the robustness of this result, we present two more counterfactual exercises that illustrate that the increase of the matching efficiency of the Federal

[15] For comparability, we use the definition of tightness as vacancies over unemployed.

[16] Compared to studies that estimate aggregate matching efficiency, this increase appears moderate. This is due to the observation period, which is longer in our case than in existing matching function estimations for Germany (Fahr & Sunde 2009, Hertweck & Sigrist 2013, Klinger & Rothe 2012, Stops 2016)

Employment Agency is unlikely to be an important driver for the decline of unemployment.

First, we show what happens when the matching efficiency of the Federal Employment Agency increases by as much as the aggregate matching efficiency (namely, by roughly 1 percent). In this case, aggregate unemployment falls by less than 0.01 percentage points. This is due to the small initial vacancy share and matching share of the Federal Employment Agency. In different words, moderate increases of the matching efficiency basically have close to zero effects on aggregate unemployment.

Table 7: Policy responses Agency

Counterfactual	(1) $\Delta log\, \psi_1^a = 0.01$	(2) $\Delta log\, \psi_2^a$=0.26
Unemployment	-0.00	-0.04
Vacancy Share	0.38	9.95
Matching Share	0.09	2.40

Second, we increase the agency's matching efficiency such that we can replicate the aggregate increase of matching efficiency by this shock alone. In this case, the agency's matching efficiency would have to rise by 26 percent, which appears to be very large. However, as can be seen from the second column of Table 7, the effect on unemployment is still limited.

In intuitive terms, generating a substantial decline of unemployment through the Federal Employment Agency would require a very large increase of public matching efficiency. This is the case, as the Federal Employment Agency has a matching share of only around 10 percent in steady state. Furthermore, a strong increase of public matching efficiency would increase the public matching share substantially which can be seen in the second column of Table 7. Such an increase is at odds with the data.

6 Conclusion

Our paper shows that the matching share of the Federal Employment Agency fell in the aftermath of the Hartz reforms, despite an increase of the vacancy share. We propose a new labor market model with a private and a public segment and calibrate it to match these facts. Our paper shows that the intermediation of jobs in Germany has indeed become more effective. However, we neither find an important direct contribution of the Federal Employment Agency in our counterfactual simulations nor in our matching function estimations. We also show that even if the Federal Employment Agency had increased its matching efficiency substantially, this would have been unlikely to result in a very large decline of unemployment. Its market share is too small for plausible matching efficiency increases to have a large aggregate effect. However, the role of the Federal Employment Agency goes beyond intermediation. We identify

better activation policies as key component of the Hartz III reform to reduce unemployment.

In addition, our paper provides an explanation for the leftward shift of the Beveridge Curve in the aftermath of the Hartz reforms. Better activation policies through the PEA lead to a stronger use of the (more efficient) private market and thereby shift the aggregate Beveridge Curve.

References

Blanchard, O. & Galí, J. (2010), 'Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment', *American Economic Journal: Macroeconomics* **2**(2), 1–30.

Bossler, M., Gartner, H., Kubis, A., Küfner, B. et al. (2020), The IAB Job Vacancy Survey: Establishment Survey on Labour Demand and Recruitment Processes, Waves 2000 to 2017 and Subsequent Quarters 2006 to 2018, FDZ-Datenreport 06/2020, Nuremberg.

Bossler, M., Gürtzgen, N., Kubis, A. & Moczall, A. (2018), IAB-Stellenerhebung von 1992 bis 2017: So wenige Arbeitslose pro offene Stelle wie nie in den vergangenen 25 Jahren, IAB-Kurzbericht 23/2018, Nuremberg.

Carrillo-Tudela, C., Launov, A. & Robin, J.-M. (2021), 'The Fall in German Unemployment: A Flow Analysis', *European Economic Review* **132**, 103658.

Fahr, R. & Sunde, U. (2009), 'Did the Hartz Reforms Speed-up the Matching Process? A Macro-Evaluation Using Empirical Matching Functions', *German Economic Review* **3**(10), 284–316.

Franz, W. (2013), *Arbeitsmarktökonomik, 8. aktualisierte und ergänzte Auflage*, Springer Gabler.

Gartner, H., Merkl, C. & Rothe, T. (2012), 'Sclerosis and Large Volatilities: Two Sides of the Same Coin', *Economics Letters* **117**, 106–109.

Gartner, H., Rothe, T. & Weber, E. (2019), The Quality-weighted Matching Function: Did the German Labour Market Reforms Trade Off Efficiency against Job Quality?, IAB Discussion Paper 201924.

Goebel, J., Grabka, M. M., Liebig, S., Kroh, M., Richter, D., Schröder, C. & Schupp, J. (2019), 'The German Socio-Economic Panel (SOEP)', *Jahrbücher für Nationalökonomie und Statistik* **239**(2), 345–360.

Hainmueller, J., Hofmann, B., Krug, G. & Wolf, K. (2016), 'Do Lower Caseloads Improve the Performance of Public Employment Services? New Evidence from German employment offices', *The Scandinavian Journal of Economics* **118**, 941–974.

Hamjediers, M., Schmelzer, P. & Wolfram, T. (2018), Do-files for working with SOEP Spell Data, SOEP Survey Papers 492, Berlin.

Hartung, B., Jung, P. & Kuhn, M. (2018), What hides behind the German Labor Market Miracle? Unemployment Insurance Reforms and Labor Market Dynamics, CEPR Discussion Paper DP13328.

Hertweck, M. S. & Sigrist, O. (2013), 'The aggregate Effects of the Hartz Reforms in Germany', *SOEPpapers on Multidisciplinary Panel Data Research* **532**.

Hochmuth, B., Kohlbrecher, B., Merkl, C. & Gartner, H. (2021), 'Hartz IV and the Decline of German Unemployment: A Macroeconomic Evaluation', *Journal of Economic Dynamics and Control* **127**, 104114.

Holzner, C. & Watanabe, M. (2020), Intermediation Services and Search Friction, mimeo.

Holzner, C. & Watanabe, M. (2021), The Wage Effect of Vacancy Referrals from the Public Employment Agency, mimeo.

Jacobi, L. & Kluve, J. (2021), 'Before and After the Hartz Reforms: The Performance of Active Labor Market Policy in Germany', *Journal of Labour Market Research* **127**, 45–64.

Klein, M. & Stefan, S. (forthcoming), 'What Accounts for the German Labor Market Miracle? A Structural Var Approach', *Macroeconomic Dynamics* .

Klinger, S. & Rothe, T. (2012), 'The Impact of Labour Market Reforms and Economic Performance on the Matching of the Short-term and the Long-term Unemployed', *Scottish Journal of Political Economy* **59**(1), 90–114.

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

Krause, M. U. & Uhlig, H. (2012), 'Transitions in the German Labor Market: Structure and Crisis', *Journal of Monetary Economics* **59**(1), 64–79.

Krebs, T. & Scheffel, M. (2013), 'Macroeconomic Evaluation of Labor Market Reform in Germany', *IMF Economic Review* **61**(4), 664–701.

Launov, A. & Wälde, K. (2013), 'Estimating Incentive and Welfare Effects of Nonstationary Unemployment Benefits', *International Economic Review* **54**(4), 1159–1198.

Launov, A. & Wälde, K. (2016), 'The Employment Effect of Reforming a Public Employment Agency', *European Economic Review* **84**, 140 – 164. European Labor Market Issues.

Lochner, B., Merkl, C., Stüber, H. & Gürtzgen, N. (2020), 'Recruiting Intensity and Hiring Practices: Cross-Sectional and Time-Series Evidence', *Labour Economics* (101939).

Pissarides, C. (1979), 'Job Matchings with State Employment Agencies and Random Search', *Economic Journal* **89**(356), 818–33.

Pissarides, C. A. (2000), *Equilibrium Unemployment Theory, 2nd Edition*, MIT press.

Schiprowski, A. (2020), 'The Role of Caseworkers in Unemployment Insurance: Evidence from unplanned Absences', *Journal of Labor Economics* **38**(4), 1189–1225.

Stops, M. (2016), 'Revisiting German Labour Market Reform Effects—A Panel Data Analysis for Occupational Labour Markets', *IZA Journal of European Labor Studies* **14**, 2193–9012.

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

7 Appendix A: Details on Hartz Reforms

7.1 Different Reform Steps

The so called Hartz commission (named after the head of the commission, Peter Hartz) developed recommendations how to reform the German labor market in order to reduce unemployment. The guiding principle for these reform was "Fordern und Fördern" (translation: demanding and supporting). The recommendation were implemented gradually, starting in 2003 (see Hochmuth et al. (2021) or Launov & Wälde (2016) for a more detailed description):

Hartz I (implemented in 2003): The first package of the Hartz reform facilitated temporary work contracts. In addition, it introduced vouchers for training.

Hartz II (implemented in 2003): The second package introduced new types of marginal employment, with reduced social security contributions for low income contracts. In addition, it introduced subsidies for unemployed workers to transition into self-employment.

Hartz III (implementation, started in 2004, the full roll-out ended in late 2005, see Holzner & Watanabe (2021) for details): The core element of Hartz III was the restructuring of the Federal Employment Agency (see Launov & Wälde (2016) for details). With the introduction of Hartz III, all claims of an unemployed person were processed by the same case worker (support from a single source) and an upper limit on the number of cases handled by one single case worker was introduced. In addition, market elements for private placement services and providers of training measures were introduced.

Hartz IV (implemented in 2005 and 2006): The last step of the Hartz-reforms changed the unemployment benefit system for long-term unemployed. Before Hartz IV, long-term unemployed received benefits that were dependent on their prior net earnings. With the introduction of Hartz IV, long-term unemployed had to go through a strict means test and received a fixed transfer (independent of their prior income). See Hochmuth et al. (2021) for details.

7.2 Activation and Counseling

As part of the Hartz III reform, the Federal Employment Agency offered new services to unemployed workers, such as advising and counseling. In addition, individuals that were not placed by the PEA within six weeks received subsidies for a private placement service (see Jacobi & Kluve (2021) for institutional details, in particular their Section 3). Furthermore, the Hartz reform introduced new sanctions to monitor unemployed workers' job search activities.

We are not able to differentiate these measures in our macroeconomic matching exercise. However, all of them have in common that they stimulate private search activities of unemployed workers. In our numerical, exercise we show that activation and counseling policies play an important role to explain the macroeconomic patterns after the Hartz reforms.

8 Appendix B: Model Derivations

8.1 Household

Each unemployed worker has to make the decision whether to search privately herself or to rely only on the agency to find a job. For this decision, the probabilities of finding a job in both cases are important. If no private search is carried out, the probability of being employed in the next period is:

$$\frac{c_t^a - \iota_t^a q_t^p q_t^a f_t}{s_t} = p_t^a(1 - \iota_t^a q_t^p). \tag{36}$$

The agency creates c_t^a contacts which are spread across s_t searchers. Although the considered unemployed worker herself does not search privately there is a possibility that she is not employed in the next period even though a contact is made. This possibility results from the fact that the share g_t of vacancies is on both search markets. The considered worker can therefore come into contact with a vacancy, which is then filled with a worker who has searched privately. If the worker decides to search privately she gets the additional probability to be employed in the next period:

$$\begin{aligned}
&\frac{c_t^p - c_t^p p_t^a - \iota_t^p q_t^p q_t^a f_t}{u_t} \\
=&\frac{c_t^p - c_t^p p_t^a - \iota_t^p q_t^a \frac{c_t^p}{v_t} v_t g_t}{u_t} \\
=&\frac{c_t^p(1 - p_t^a - \iota_t^p q_t^a g_t)}{u_t} \\
=&p_t^p(1 - p_t^a - \iota_t^p q_t^a g_t).
\end{aligned}$$

Again, there is a possibility that the vacancy will be filled with a worker who came in contact with the vacancy through the other search market. In addition, there is the possibility that the worker comes into contact with two vacancies. Since she can only accept one job offer, this possibility reduces the extra probability of finding a job. If the considered unemployed worker carries out a private search, her overall probability of being employed in the next period is:

$$p_t^a(1 - \iota_t^a q_t^p) + p_t^p(1 - p_t^a - \iota_t^p q_t^a g_t). \tag{37}$$

Given equation (36) the expected present value of unemployment for an unemployed worker i who only searches via the agency can be written as:

$$U_{it}^a = b^r + \beta p_t^a(1 - \iota_t^a q_t^p) E_t W_{t+1} + \beta(1 - p_t^a(1 - \iota_t^a q_t^p)) E_t U_{t+1}. \tag{38}$$

The corresponding value for an unemployed worker who searches privrtly can be written using equation (37):

$$U_{it}^{p} = b - e_{it} + \beta(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t))E_t W_{t+1} \\ +\beta(1-(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)))E_t U_{t+1}. \tag{39}$$

We can now examine the search decision of a job seeker. In each period each job seeker draws an idiosyncratic iid cost shock e_{it} from a stable distribution $H(e_t)$. After the level of the cost shock is realized, the job seeker compares this costs with the expected utility gain from searching privately. Hence the job seeker compares the values of (38) and (39) given her own search cost e_{it}. She will use the private market if

$$U_{it}^{p} \geq U_{it}^{a} \Rightarrow U_{it}^{p} - U_{it}^{a} \geq 0. \tag{40}$$

Using (38) and (39):

$$U_{it}^{p} - U_{it}^{a} = b - b^r + p_t^p(1-p_t^a-\iota_t^p g_t q_t^q)\beta E_t(W_{t+1}-U_{t+1}) - e_{it}. \tag{41}$$

Inserting into equation (40) gives

$$e_{it} \leq b - b^r + p_t^p(1-p_t^a-\iota_t^p g_t q_t^a)\beta E_t(W_{t+1}-U_{t+1}). \tag{42}$$

This allows us to define $\tilde{e}_t$ as the highest possible value for e_{it} at which a private search is still carried out.

$$\tilde{e}_t = b - b^r + p_t^p(1-p_t^a-\iota_t^p g_t q_t^a)\beta E_t(W_{t+1}-U_{t+1}) \tag{43}$$

Every job seeker who draws a value of $e_{it} \leq \tilde{e}_t$ uses the private market. Thus the share of privately searching job seekers is

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h\left(e_t\right) de_t. \tag{44}$$

The conditioned expected value of search costs is.

$$\widehat{e}_t = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h\left(e_t\right) de_t}{H(\tilde{e}_t)}. \tag{45}$$

8.2 Firm

A vacancy is posted only on the private market has the following probability to be filled in the next period:

$$\frac{c_t^p - \iota_t^p p_t^p p_t^a u_t}{v_t} = q_t^p(1-\iota_t^p p_t^a). \tag{46}$$

Reporting the vacancy to the agency increases the probability by:

$$
\begin{aligned}
&\frac{c_t^a - c_t^a q_t^p - \iota_t^a p_t^p p_t^a u_t}{f_t} \\
=&\frac{c_t^a - c_t^a q_t^p - \iota_t^a p_t^p \frac{c_t^a}{s_t} s_t \xi_t}{f_t} \\
=&\frac{c_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)}{f_t} \\
=&q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t).
\end{aligned}
$$

The representative has the following maximization problem:

$$
\max_{n_{t+1}, v_t, g_t} E_0 \sum_{t=0}^{\infty} \beta \{(a_t - w_t) n_t - v_t^p (\kappa^p + \kappa^a g_t)\}
$$

$$
s.t.
$$

$$
n_{t+1} = (1 - \phi) n_t + v_t^p q_t^p (1 - \iota_t^p p_t^a) + v_t^p g_t q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)
$$

The corresponding Lagrangian is:

$$
\begin{aligned}
L = E_0 \sum_{t=0}^{\infty} \beta^t \{&(a_t - w_t) n_t - v_t^p (\kappa^p + \kappa^a g_t) \\
&- \lambda_t [n_{t+1} - (1 - \phi) n_t - v_t^p q_t^p (1 - \iota_t^p p_t^a) - v_t^p g_t q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)]\}
\end{aligned}
$$

The first-order conditions are:

$$
\begin{aligned}
\frac{\partial L}{\partial n_{t+1}} &= E_t \beta [a_{t+1} - w_{t+1}] - \lambda_t + E_t \lambda_{t+1} \beta (1 - \phi) \stackrel{!}{=} 0 \\
\lambda_t &= E_t \beta [a_{t+1} - w_{t+1}] + E_t \lambda_{t+1} \beta (1 - \phi) \qquad (47)
\end{aligned}
$$

$$
\frac{\partial L}{\partial v_t^p} = -(\kappa^p + \kappa^a g_t) + \lambda_t q_t^p (1 - \iota_t^p p_t^a) + \lambda_t g_t q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t) \stackrel{!}{=} 0
$$

$$
\lambda_t = \frac{\kappa^p + \kappa^a g_t}{q_t^p (1 - \iota_t^p p_t^a) + g_t q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)} \qquad (48)
$$

$$
\begin{aligned}
\frac{\partial L}{\partial g_t} &= -v_t^p \kappa^a + \lambda_t v_t^p q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t) \stackrel{!}{=} 0 \\
\lambda_t &= \frac{\kappa^a}{q_t^a (1 - q_t^p - \iota_t^a p_t^p \xi_t)} \qquad (49)
\end{aligned}
$$

Now we can combine equations (48) and (49):

$$\frac{\kappa^a}{q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t)} = \frac{\kappa^p + \kappa^a g_t}{q_t^p(1-\iota_t^p p_t^a) + g_t q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t)}. \tag{50}$$

This can be rearranged to:

$$\begin{aligned} &\kappa^a q_t^p(1-\iota_t^p p_t^a) + \kappa^a g_t q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t) \\ &= \kappa^p q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t) + \kappa^a g_t q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t) \end{aligned}$$

$$\kappa^a q_t^p(1-\iota_t^p p_t^a) = \kappa^p q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t)$$

Taking equation (49) into account:

$$\lambda_t = \frac{\kappa^a}{q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t)} = \frac{\kappa^p}{q_t^p(1-\iota_t^p p_t^a)} \tag{51}$$

Now we can insert (51) into (47) to obtain two job-creation-conditions:

$$\begin{aligned} \frac{\kappa^a}{q_t^a(1-q_t^p-\iota_t^a p_t^p \xi_t)} = E_t \beta((&a_{t+1} - w_{t+1}) \\ &+ (1-\phi)\frac{\kappa^a}{q_{t+1}^a(1-q_{t+1}^p-\iota_{t+1}^a p_{t+1}^p \xi_{t+1})}) \end{aligned} \tag{52}$$

$$\frac{\kappa^p}{q_t^p(1-\iota_t^p p_t^a)} = E_t \beta((a_{t+1} - w_{t+1}) + (1-\phi)\frac{\kappa^p}{q_{t+1}^p(1-\iota_{t+1}^p p_{t+1}^a)}) \tag{53}$$

8.3 Wage Bargaining

The expected value of unemployment for privately searching unemployed workers can be written as

$$\begin{aligned} \bar{U}_t^p = b - \widehat{e_t} + \beta(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t))E_t W_{t+1} \\ +\beta(1-(p_t^a(1-\iota_t^a q_t^p) + p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)))E_t U_{t+1} \end{aligned}$$

Where U_t is the average value of being unemployed:

$$\begin{aligned} U_t &= \xi_t \bar{U}_t^p + (1-\xi_t)U_t^a \\ U_t &= \xi_t b + (1-\xi_t)b^r - \xi_t \widehat{e_t} \\ &\quad + \beta(p_t^a(1-\iota_t^a q_t^p) + \xi_t p_t^p(1-p_t^a-\iota_t^p q_t^a g_t))E_t W_{t+1} \\ &\quad + \beta(1-(p_t^a(1-\iota_t^a q_t^p) + \xi_t p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)))E_t U_{t+1} \end{aligned}$$

Recognizing that

$$
\begin{aligned}
&p_t^a(1-\iota_t^a q_t^p) + \xi_t p_t^p(1-p_t^a-\iota_t^p q_t^a g_t)\\
&= p_t^a + \xi_t p_t^p - \xi_t p_t^p p_t^a - \iota_t^a q_t^p p_t^a - \xi_t \iota_t^p q_t^a g_t p_t^p\\
&= p_t^a + \xi_t p_t^p - \xi_t p_t^p p_t^a - \frac{1}{s_t}(\iota_t^a q_t^p c_t^a + \iota_t^p q_t^a g_t c_t^p)\\
&= p_t^a + \xi_t p_t^p - \xi_t p_t^p p_t^a - \frac{q_t^p q_t^a f_t}{s_t}\\
&= \frac{c_t^a + c_t^p - p_t^p p_t^a u_t - q_t^p q_t^a f_t}{s_t}\\
&= p_t,
\end{aligned}
$$

allows us to write the average value of beeing unemployed as

$$U_t = \xi_t b + (1-\xi_t)b^r - \xi_t \widehat{e}_t + \beta p_t E_t W_{t+1} + \beta(1-p_t)E_t U_{t+1}, \tag{54}$$

where p_t is the average job-finding-rate. The present value of employment can now be defined as

$$W_t = w_t + \beta\left((1-\phi) + \phi p_t)\right) E_t W_{t+1} + \beta\phi(1-p_t)E_t U_{t+1}. \tag{55}$$

A firm's value of a matched job is:

$$J_t = a_t - w_t + \beta E_t\left(1-\phi\right) J_{t+1}. \tag{56}$$

With (54), (55) and (56) the Nash bargaining problem can be written as:

$$w_t \in argmax\left(W_t - U_t\right)^{\gamma}\left(J_t\right)^{1-\gamma}, \tag{57}$$

which results in the following sharing rule:

$$\gamma J_t = (1-\gamma)(W_t - U_t). \tag{58}$$

8.4 Aggregation

The number of matches in each sector is:

$$m_t^a = c_t^a - \iota_t^a(p_t^p p_t^a u_t + q_t^p q_t^a f_t), \tag{59}$$

$$m_t^p = c_t^p - \iota_t^p(p_t^p p_t^a u_t + q_t^p q_t^a f_t). \tag{60}$$

where we assume that:

$$\iota_t^p = \frac{c_t^p}{c_t^a + c_t^p}, \tag{61}$$

$$\iota_t^a = \frac{c_t^a}{c_t^a + c_t^p}. \tag{62}$$

The matching share of the agency is defined as:

$$Q_t = \frac{m_t^a}{m_t}. \tag{63}$$

Given (59) and (62) this can be rewritten as:

$$\begin{aligned}
Q_t &= \frac{m_t^a}{m_t} \\
&= \frac{c_t^a - \iota_t^a (p_t^p p_t^a u_t + q_t^p q_t^a f_t)}{c_t^a + c_t^p - p_t^p p_t^a u_t + q_t^p q_t^a f_t} \\
&= \frac{c_t^a - \frac{c_t^a}{c_t^a + c_t^p} (p_t^p p_t^a u_t + q_t^p q_t^a f_t)}{c_t^a + c_t^p - p_t^p p_t^a u_t + q_t^p q_t^a f_t} \\
&= \frac{c_t^a (1 - \frac{1}{c_t^a + c_t^p} (p_t^p p_t^a u_t + q_t^p q_t^a f_t)}{(c_t^a + c_t^p)(1 - \frac{1}{c_t^a + c_t^p} (p_t^p p_t^a u_t + q_t^p q_t^a f_t))}
\end{aligned}$$

$$Q_t = \frac{c_t^a}{c_t^a + c_t^p}. \tag{64}$$

9 Appendix C: Data and Further Empirical Facts

9.1 Data

German Socio Economic Panel:

As stated before we construct the matching share of the agency from the German Socioeconomic Panel (GSEOP). We also use it to get our target for the share of privately searching unemployed. The GSOEP is a longitudinal survey covering approximately 30000 individuals. For further descriptions of the GSOEP, see Goebel et al. (2019). Since we use the wave 35 we have observations from the starting year of the GSOEP 1984 up to the year 2018. However, due to variations in the questionnaires, the time period of the data used is restricted depending on the variable constructed from the GSOEP. For our calibration we use observations from individuals living in West Germany.

The basis for the share of privately searching unemployed is the question whether a non employed individual has been actively searching employment in the last four weeks. To stay close to the model, we only use individuals registered as unemployed at the agency. Since the question whether an active search is being carried out includes the search via the employment agency as active search, a further adjustment is necessary. For the years 2003-2007, additional information is available on the channels through which employment is searched for. For these years, the share of active searching, registered unemployed who are not only searching through the agency is calculated using the cross-sectional individual weights. The corresponding value for West Germany for the year 2003 is the stated target.

For the matching share we use the question, how an individual found out about her new position. This question is only answered by individuals who started there current employment in the year of the questionnaire or in the year before. The construction of the time series shown in section 2 and used as a target in section 4 takes the possibility that the employment started in the year before the questionnaire into account. In addition, we exclude individuals who claim to have become self-employed, who have changed jobs in the same firm, and who have stated multiple channels. We also add job centers to the agency and exclude personnel service agencies. Finally, we also count individuals who found their job with the help of a voucher from the agency to the matches of the agency. The survey also includes the question what type of occupational change occurred. Based on this question we again exclude individuals who change there job in a firm and individuals who switch into self-employment as well as individuals for whom this information is missing. We also exclude apprenticeship positions, individuals who are employed in a sheltered workshop, 1 Euro jobs and public job creation schemes (ABM) positions as well as returnees from parental leave for all years with the respective information. Finally, employees older than 65 are excluded. Based on this adjustments we calculate the matching share of the agency using the cross-sectional individual weights. Not all necessary questions were asked before the time period considered in the main text. That is why the corresponding adjustments were not possible in the longer time series in Figure A1. The time series in figure A3 is based on the same adjustments. Additionally information of the GSOEP spell data is used to get the information in which month unemployment spells are ending. For this the do-files by Hamjediers et al. (2018) are used. The shown times series is the matching share if an unemployment spell ended in the month in which the new position started or one month before.

IAB Job Vacancy Survey:

The data we use for the vacancy share, for the additional time series of the matching share and for vacancies come for the IAB Job Vacancy Survey (Bossler et al. 2020). The Job Vacancy Survey is a repeated cross section with the target to to provide information on the unfilled labor demand in Germany. It was carried out for the first time in the year 1989 and covers up to around 14000 establishments.

The vacancy share is based on the question how many vacancies an establishment has. In parallel, it is asked how many of these have been reported to the agency. The ratio of the two, each weighted by the weighting factors, gives the vacancy share. In addition, more detailed questions are asked on the last successful hire. Two of these questions are, which search channels were used and which of those led to the hiring. The later is the question used for the Job Vacancy Survey time series on the Matching Share. From 2004 onward, the agency's internet services are listed as a separate response option in the questionnaire. We add the matches resulting from this option to the matches of the agency. The share of hires for which the agency was stated as the recruitment channel is the matching share. The corresponding weighting factors have been

used.
We use the number of vacancies from the Job Vacancy Survey for our target of the public tightness. The number of unemployed as well as the the data on the job finding rates are from the estimations are from the Integrated Labour Market Biographies (vom Berge et al. 2013). For more details see Hochmuth et al. (2021) Appendix B.

9.2 Vacancy and Matching Share: Robustness

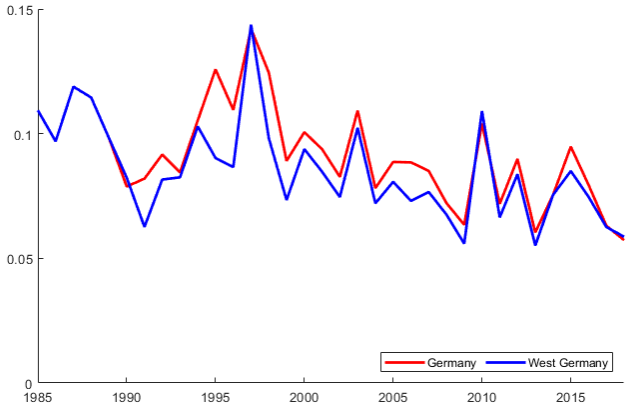

Figure A1: Matching Share. The figure shows the matching share of the agency based on GSOEP for a longer time period. As described in section 9.1, not all adjustments were possible.

Table A1: Matching Shares for Loosely Connected Unemployed

	Pre Reform	Post Reform
Germany	0.32	0.20
West Germany	0.29	0.18

Note The table shows the average matching share before and after the year 2004 for individuals with a loose connection to the labor market. These are defined as individuals which have been unemployed for 12 month or more in the survey period in which they stated that they started the new position and in the survey period before. Only new positions that end an unemployment spell are included. Individuals are weighted with the cross-sectional weights.

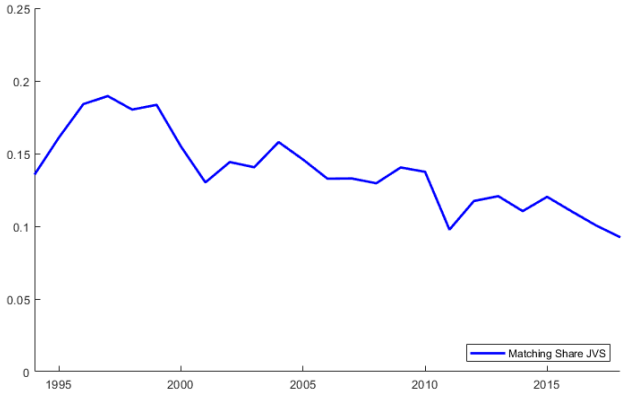

Figure A2: Matching Share. The figure shows the matching share of the agency based on IAB JVS.

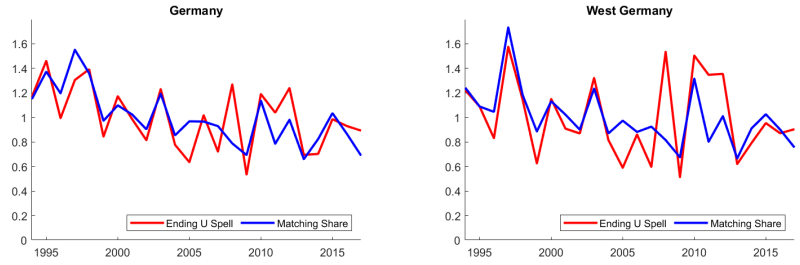

Figure A3: The figure shows the matching share based on all observations in blue and the matching share that is restricted to observation where an unemployment spell ended in the month of the match or the month before in red. Both time series are normalized to a mean of one. On average the restricted matching share was roughly 5 percentage points lower for Germany and 2.5 percentage points lower for West Germany in the post reform period.

9.3 Matching Function Estimations

Table A2: Estimated matching functions

	log(aggregate jfr)	log(agency jfr)
	(1)	(2)
log(market tightness)	0.28***	
	(0.03)	
log(public market tightness)		0.16***
		(0.05)
Hartz III Dummy	0.07**	-0.14
	(0.03)	(0.08)
Constant	-2.60***	-5.01***
	(0.05)	(0.13)
Observations	26	26
R^2	0.82	0.20
F Statistic	55.41***	6.15***

Note: Robust standard errors are shown in brackets; $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Apart from the Hartz III dummy, the procedure is as described in footnote 11.

9.4 Probability of Being Matched via the PEA

Table A3 shows how the individual-level probability of being matched via the agency shifted after the reforms (Hartz III dummy). It controls for aggregate and individual-level observables. The estimations are based on individual-level data from GSOEP.

In line with our descriptive evidence from the main part, the probability of being matched via the agency drops in the aftermath of the Hartz reforms. Thus, this fact is robust to controlling for individual-level characteristics.

Table A3: Probability of being matched via the agency

Dependent Variable: Match was through Agency						
	(1)	(2)	(3)	(4)	(5)	(6)
Hartz III Dummy	-0.016***	-0.015***	-0.016***	-0.014***	-0.008*	-0.011**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Tightness		-0.010	-0.012	-0.011	-0.015	-0.025*
		(0.014)	(0.014)	(0.014)	(0.013)	(0.014)
Age			X	X	X	X
Sex			X	X	X	X
Required qualification				X	X	X
Full time or other					X	X
Migration						X
Family situation						X
N	21591	21591	21591	21591	21591	21591
R^2	0.001	0.001	0.003	0.009	0.018	0.021

Note: Clustered standard errors are shown in parentheses; $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. The estimation results are based on the equation $\delta_{it}^{Agency} = \beta_0 + \beta_1 \delta_t^{2004} + \beta_2 \Theta_t^u + \alpha X_{it} + \epsilon_{it}$, which is estimated as a linear probability model. δ_{it}^{Agency} is a dummy variable that indicates if the new position was found through the agency. The variable δ_t^{2004} is zero before the year 2004 and one afterwards. Θ_t^u denotes the labor market tightness and X_{it} is a vector of individual controls. Only individuals form West Germany are included.