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DISCUSSION PAPER SERIES

IZA DP No. 15714

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ISSN: 2365-9793

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ABSTRACT

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

Our paper analyzes the role of public employment agencies in job matching, in particular 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 0.8 percentage points. Through the lens of an aggregate matching function, more activation is associated with a larger matching efficiency.

JEL Classification: E24, E00, E60

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

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* We are grateful to Hermann Gartner and Alexander Kubis for providing data on job vacancies for Germany. We would like to thank Anja Bauer, Hermann Gartner, Brigitte Hochmuth, Michael Stops, Klaus Wälde, as well as participants at the European Economic Association, the Verein für Socialpolitik, the Austrian Economic Association, 13th IAAEU Workshop on Labour Economics, the internal IAB seminar, and the 11th ifo Conference on Macroeconomics and Survey Data, the BGPE Research Workshop, the 13th interdisciplinary Ph.D. workshop "Perspectives on (Un-) Employment," the final international conference of the DFG Priority Program 1764 and the 26th Spring Meeting of Young Economists for valuable feedback. We would like to thank Christian Holzner for discussing our paper at the Bavarian Macro Workshop. We thank the German Research Foundation for funding (grant number: ME-3887/5-1).

1 Introduction

Labor market reforms are a standard recommendation of international organizations to bring down unemployment (e.g. Cacciatore et al. (2016), Cacciatore & Fiori (2016), Duval & Furceri (2018), IMF (2015)). Registered unemployment in Germany declined from around 12 percent in 2005 to less than 6 percent in 2018. 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 the 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. Eichhorst et al. (2013) document that a large fraction of workers uses a PEA in different European countries.

Our paper proposes a new model framework where 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

[1] See for example Krause & Uhlig (2012), Krebs & Scheffel (2013), Launov & Wälde (2013), Hochmuth et al. (2021), Hartung et al. (2022).

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

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 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. The reason is, that the share of searching workers that uses the private search market increases in a boom. At the same time the overall number of searching workers decreases. Because of this search behavior of workers, 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

[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. 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.

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 0.8 percentage points of unemployment. This order 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 3 derives a novel theoretical model. Section 4 presents the calibration strategy. Section 5 shows results and counterfactual exercises. Section 6 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 larger 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

Figure 2: Matching Share. The figure shows the matching share based on the GSOEP. More details can be found in section 10.1.

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 matching share is subject to a long-lasting downward trend. Figure A2 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.[5] 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.[6]

Finally, we analyze the business cycle properties of vacancy and matching share. Figure 3 shows that the vacancy share comoves negatively with unem-

[4]As can be seen in Figure A4, the decrease in the matching share remains when only observations with an ending unemployment spell at the time the new position starts are included.

[5]In addition, we estimate the effect of the Hartz III reform on the individual probability of being matched via the agency (controlling for personal characteristics, based on GSOEP) and find a negative effect. See Table A3 in the Appendix.

[6]From Table A1, 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.

ployment, 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. 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.

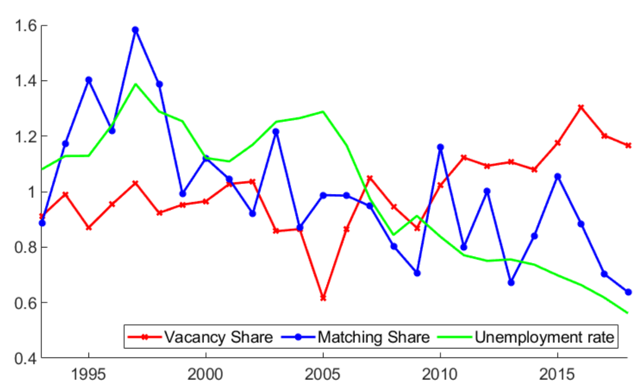

Figure 3: Vacancy share, matching share and unemployment over time. All variables are normalized such that they are one on average.

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, chapter 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 unemployment 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 searching workers 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[7] and by formal unemployment registration requirements for unemployed workers by the agency. In addition, households may be using a private search channel. We assume that 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 for whom the expected returns from private search are greater than the cost search privately. The household with the highest search costs that is still searching privately is indifferent between searching privately and searching only through the agency. This means that they are indifferent at the cutoff point $\tilde{e}_t$.

The value of search via the agency is:

$$S_t^a = p_t^a W_t^a + (1 - p_t^a) U_t^a, \tag{7}$$

where W_t^a is the value of employment found through the agency and U_t^a is the value of unemployment if the private search channel was not used.

The value for a worker who uses both the agency and the private search channel is defined as follows:

$$\begin{aligned} S_t^p = {} & -e_{it} + (p_t^a - p_t^a p_t^p) W_t^a + (p_t^p - g_t q_t^a p_t^p) W_t^p \\ & + (1 - (p_t^a - p_t^a p_t^p) - (p_t^p - g_t q_t^a p_t^p)) U_t^p, \end{aligned} \tag{8}$$

where W_t^p is the value of employment found through the private market U_t^p is the value of unemployment if the private search channel was used. The first term on the right-hand side is the idiosyncratic search cost component. The next two terms represent the probability and the expected returns to match through one of the two channels. The probability to match via the agency is reduced by the term $p_t^a p_t^p$, which is the probability of a double match (both through the agency and the private market). Given the higher wage for private market

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

matches (see discussion in section 3.4), the worker will always decide in favor of the private match (in case of a choice). For a similar reason, the probability of being matched through the private market is reduced by the term $g_t q_t^a p_t^p$, where g_t is the probability that a given vacancy is registered at the agency. The term represents the case where a worker gets in contact with a vacancy that is registered at the agency and the firm makes a second contact through the agency. Because of the wage differences, the firm chooses the agency contact. If the worker makes no match, he will get the respective value of unemployment.

Combining equations 7 and 8 yields the cutoff point at which workers are indifferent between searching privately or not:

$$\tilde{e}_{it} = \left(p_t^p - g_t q_t^a p_t^p\right)\left(W_t^p - U_t^p\right) - p_t^a p_t^p \left(W_t^a - U_t^p\right) + \left(1 - p_t^a\right)\left(b - b^r\right) \tag{9}$$

where the right-hand side of the equation shows the additional returns for a worker when searching via the private market. The first term shows the additional return from private matches.[8] The second term accounts for the fact that some of the matches that were realized via the private market would have taken place via the agency in any case (although potentially at a lower wage). The third term shows up because even in case of no match, having searched privately may bring the advantage of not being sanctioned by the agency.

If the agency sanctions unemployed workers who do not search privately, those workers receive reduced benefits b^r, such that $b > b^r$ holds. As we will show in the wage formation part, this leads to lower wages for pure agency matches.

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

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h\left(e_t\right) de_t, \tag{10}$$

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

$$\widehat{e}_t = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h\left(e_t\right) de_t}{\xi_t}. \tag{11}$$

3.3 Search Decision: Firms

Firms' primary search channel is the private search market. We assume that they post all 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).

[8] We account for the fact that firms that receive several applications will opt for the (potentially) agency match that is associated with lower wages. g_t is the share of agency matches, which will be defined in the next subsection.

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 cost per registered vacancy (e.g. because this vacancy has to be reported to the system of the PEA).

The share of registered vacancies is defined as

$$g_t = \frac{f_t}{v_t}. \tag{12}$$

Firms maximize intertemporal expected profits:

$$\max_{m_t^a, n_t^p, v_t, g_t} E_0 \sum_{t=0}^{\infty} \beta^t \{(a_t - w_t^p) n_t^p + (a_t - w_t^a) m_t^a - v_t(\kappa^p + \kappa^a g_t)\} \tag{13}$$

subject to the constraints:

$$n_t^p = (1-\phi) n_{t-1}^p + (1-\phi) m_{t-1}^a + v_t (q_t^p - q_t^a q_t^p g_t) \tag{14}$$

$$m_t^a = v_t g_t (q_t^a - q_t^a p_t^p \xi_t) \tag{15}$$

Period-by-period profits are the difference between productivity, a_t, and wages. As matches via the agency and matches via the private market (plus existing matches) may be paid different wages, we have to differentiate these two groups. m_t^a stands for new agency matches and w_t^a is their wage. n_t^p stands for the sum of private matches and incumbent workers, with the respective wage. In order to find new workers, vacancy posting has to take place. The firm posts all vacancies as private vacancies v_t at the vacancy posting cost κ^p per vacancy. Out of these vacancies, f_t vacancies are registered at the agency as well, causing a cost of κ^a per registered vacancy. Similar to the household matching probabilities, the probabilities of the firm to make a match trough one channel is not equal to the corresponding contact-finding rate. The probability of matching through the private market is reduced by $q_t^a q_t^p g_t$. With this probability, the vacancy that made a contact through the private market was registered at the agency and made a contact through the agency. The firm will decide against the private contact because of the higher wage. The probability of matching through the agency is reduced by $q_t^a p_t^p \xi_t$. With this probability, the agency contact of the vacancy also has a contact through the private market. In this situation, the worker chooses the private contact.

The maximization with respect to n_t^p, m_t^a, v_t^p, and g_t yields two job-creation conditions (see Appendix for derivations)

$$\frac{\kappa^p}{q_t^p} = a_t - w_t^p + E_t \beta (1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{16}$$

$$\frac{\kappa^a + \kappa^p q_t^a}{q_t^a - q_t^a p_t^p \xi_t} = a_t - w_t^a + E_t \beta (1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{17}$$

What is the underlying intuition for these two equations? We assumed that firms post all their vacancies automatically privately (as a new job would automatically be announced on the website or known via informal channels). The number of private vacancies is driven by a standard free-entry condition where the average expected hiring costs equal the expected returns.

In addition, a certain fraction of vacancies is posted via the agency as well. This is done up to the point where the extra returns are equal to the extra costs (accounting for double matches). The adjustment for double matches is visible in the numerator and denominator on the left hand side of the equation. In the denominator it is taken into account that workers with an agency contact prefer a private contact (due to higher wages). In the numerator the firm takes into account that it cannot match with a private contact after an agency contact is made for a specific vacancy.

In equilibrium, all atomistic firms behave in the same way. Maybe it is more intuitive to imagine the problem as a one worker-one firm problem, which is equivalent to our problem due to constant returns in production. In this case, only some firms would use two channels (private and agency). These firms would enter up to the point where the expected returns of this strategy equals the expected returns of just posting a private vacancy.

3.4 Wage Bargaining

For the search decision (see Section 3.2), we assumed that searchers receive lower unemployment benefits in case they do not search on the private market.

For the bargaining game, the out-of-equilibrium outcome of a collapsed bargain is relevant, i.e. the situation that occurs if matched workers and firms disagree and return to the labor market. This determines the fall-back option for different matching channels (see Appendix 9 for details).

We assume that if a worker who is matched via the private market and if he refuses the job, he would receive regular unemployment benefits. This worker can prove that he searched via the private market. The private contact is not necessarily known to the agency, as it was not intermediated via this channel. Thus, this worker it treated the same way as a worker who used the private channel and who did not find a job in the first place.

By contrast, a worker who only received an offer through a vacancy that was intermediated via the PEA will be sanctioned if he does not accept this job (as this will be considered as the refusal of a suitable job). We assume that a worker who refuses a job is treated in exactly the same way as a worker who did not search via the private market in the first place (and who did not find a job).

Finally, if a worker is both matched via the agency and the private channel, this information is unknown to the employer who got in contact with the worker via the private channel. Thus, in the bargaining game, he will be treated alike with a (pure) private match and thereby have a higher outside option.

This setting provides a rationale why double matches (both through the agency and private channels) will be treated as private matches. This increases workers' outside options and thereby their wages. This explains why we deducted worker double matches from agency matches and completely assigned them to private matches. As workers have the same productivity regardless of the matching channel, firms always prefer the agency contact over the private contact if a vacancy made two contacts. Thus, we subtract all firm double matches from the private matches and assign them to the agency matches.[9]

The value of a workers who matched via the agency is:

$$
\begin{aligned}
W_t^a = w_t^a &+ \beta(1-\phi)E_t W_{t+1}^p \\
&+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
&+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right]
\end{aligned} \tag{18}
$$

where ϕ is the exogenous separation rate.

$$
\begin{aligned}
U_t^a = b^r &+ \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
&+ \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right]
\end{aligned} \tag{19}
$$

where b^r are unemployment benefits that may be reduced due to sanctioning (and thereby lower than the normal benefits b) if workers only use the agency.

A worker's expected value of a match via the private market is:

$$
\begin{aligned}
W_t^p = w_t^p &+ \beta(1-\phi)E_t W_{t+1}^p \\
&+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
&+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right]
\end{aligned} \tag{20}
$$

U_t^p is the average value of being unemployed after having used the private market:

[9] In a prior version of this paper, we chose different timing assumptions that lead to the same wage for all workers. In this case, double matches had to be assigned in an arbitrary way to the private and the agency channel. The key outcomes of our papers are unaffected by these assumptions. Results are available on request.

$$U_t^p = b + \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \tag{21}$$
$$+ \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right]$$

We assume that wages are determined by Nash bargaining. This yields the following functional forms:

$$J_t^p = a_t - w_t^p + \beta E_t \left(1 - \phi\right) J_{t+1}^p, \tag{22}$$

$$J_t^a = a_t - w_t^a + \beta E_t \left(1 - \phi\right) J_{t+1}^p, \tag{23}$$

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

$$\gamma J_t^a = (1 - \gamma)(W_t^a - U_t^a). \tag{24}$$

$$\gamma J_t^p = (1 - \gamma)(W_t^p - U_t^p). \tag{25}$$

In the following, it is useful to define the variable V_{t+1}, which combines all the forward-looking terms from the difference $W_t^p - U_t^p$ and the difference $W_t^a - U_t^a$

$$V_{t+1} = W_{t+1}^p - \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \tag{26}$$
$$- \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right].$$

Using the definition of V_{t+1}, it is straightforward to write explicit equations for the wages w_t^p and w_t^a:

$$w_t^p = \gamma a_t + \left(1 - \gamma\right) b + \beta E_t \left(1 - \phi\right) \left(\gamma J_{t+1}^p - \left(1 - \gamma\right) V_{t+1}\right) \tag{27}$$

$$w_t^a = \gamma a_t + \left(1 - \gamma\right) b^r + \beta E_t \left(1 - \phi\right) \left(\gamma J_{t+1}^p - \left(1 - \gamma\right) V_{t+1}\right) \tag{28}$$

With activation policies (i.e., the attempt to motivate/force workers to use the private market on top of the agency), $U_t^p > U_t^a$ due to $b > b^r$. Given that all workers have the same productivity a, this leads to a lower wage for workers that use the agency only. This is in line with empirical evidence by Holzner & Watanabe (2021) that vacancy referral via the agency leads to lower wages.

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 number of aggregate matches m_t is:

$$m_t = c_t^a + c_t^p - p_t^p p_t^a u_t - q_t^p q_t^a f_t, \tag{29}$$

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

$$p_t = m_t / s_t \tag{30}$$

$$q_t = m_t / v_t \tag{31}$$

The number of matches via the agency is defined as the number of contacts via the agency minus the worker double matches. If workers obtain two matches (private and via the agency), they will choose the private match, as this yields a higher wage.[10]

$$m_t^a = c_t^a - p_t^p p_t^a u_t. \tag{32}$$

The number of matches via the private search channel is defined as the number of private contacts minus the firm-sided double matches (where the firms will opt for the agency match with the lower wage):

$$m_t^p = c_t^p - q_t^p q_t^a f_t. \tag{33}$$

Now we can define the matching share of the agency as

$$Q_t = \frac{m_t^a}{m_t} \tag{34}$$

matching share can be rewritten as

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:

The overall employment is given by

$$n_t = m_t^a + n_t^p \tag{35}$$

[10] In a prior version of this paper, we assumed a different wage formation that lead to the same wage for all workers. In this case, we had to choose a rule for the share of private and agency matches. All our key results are unaffected by this assumption.

where n_t^p is

$$n_t^p = (1-\phi)n_{t-1}^p + (1-\phi)n_{t-1}^a + m_t^p \tag{36}$$

$$s_t = 1 - n_{t-1} + \phi n_{t-1} \tag{37}$$

$$u_t = \xi_t s_t, \tag{38}$$

$$s_t^u = 1 - n_t. \tag{39}$$

Equation (35) aggregates agency matches and all existing matches (plus new private matches),[11] defined in equation (36), the law of motion for employment. We assume that newly unemployed workers can be immediately rehired. Thus, equation (37) gives the number of job seekers. Given the share of active searching job seekers ξ_t, their level is determined by equation (38). The number of unemployed is given by equation (39).

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 $b = 0.6$. We set the reduced benefits in the pre-reform steady state to $b^r = 0.59$.[12]

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).[13] To hit 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.

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 scale parameter 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.[15] For

[11] These are treated alike as new private matches and existing matches earn the same wage.

[12] Thereby, we assume that the agency also sanctioned before the reforms. However, much less so than after the Hartz III reform. This assumption is chosen in order to be able to assign double matches to one of the two channels before the reform.

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

[14] We use the quarterly job finding rate from Gartner et al. (2012).

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

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	0.09	Literature[14]

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	0.13
Location parameter cost distribution	μ	0.03
Scale parameter cost distribution	σ	0.30
Separation rate	ϕ	0.01
Vacancy posting costs	κ^p	0.81
Vacancy posting costs	κ^a	0.12
Matching efficiency	ψ^p	0.14
Matching efficiency	ψ^a	0.01

this purpose, we set α_a and α_p.[16] 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). For all stochastic simulations, we use the extended path method based on by Fair & Taylor (1983) to simulate the model without relying on a low order approximation.

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

[16] 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.

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 $\eta = b - b^r$. 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 an exact matching of 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 reaction of our calibrated model. This allows us to check whether 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 joint surplus shock). As usual in search and matching model, this shock increases firms' vacancy posting, it increases workers' job-finding rate and it thereby reduces unemployment.

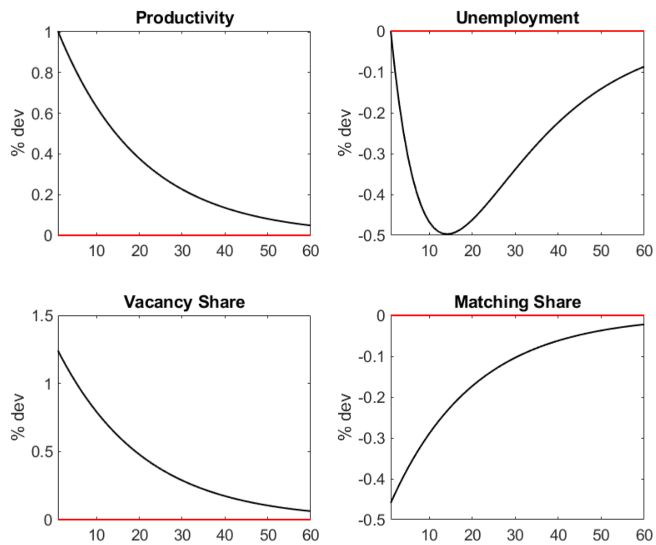

Figure 4: Response to a productivity shock

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 raises 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 before 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.[17]

Table 5: Policy responses with sanctions

	$\Delta\psi^a$	$\Delta\eta$	$\Delta(a-b)$	Joint Effects
Unemployment	0.01	-0.76	-2.07	-2.35
Vacancy Share	-1.85	-0.38	5.58	2.36
Matching Share	-0.47	-0.68	-1.27	-1.98

According to our matching exercise in Table 5, the matching efficiency of the Federal Employment Agency fell after the Hartz reforms.[18] 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 in 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 of unemployment of around -0.8 percentage points.[19] 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

[17] In contrast to Coe & Snower (1997), we do no have policy complementarities.

[18] $\Delta\psi^a/\psi_0^a = -4.51\%$

[19] The result is generated by sanctions of $\Delta\eta = 0.07$.

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[20] 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 (in order to match the overall change).

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, this paper remains 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. (2022), 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 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 pattern is completely in line with the actual leftward shift of the actual Beveridge Curve in Germany in the aftermath of the Hartz reforms.

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

[20] $\Delta(a-b) = 0.22$

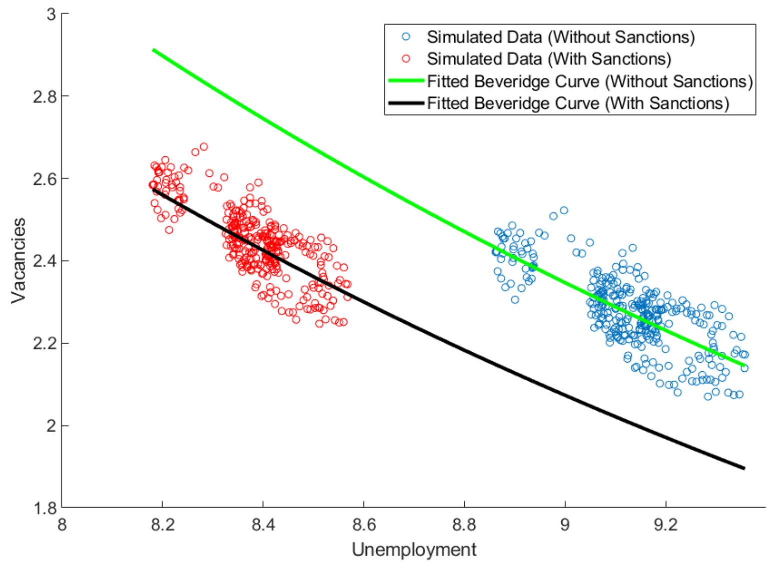

Figure 5: Beveridge Curve

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:

$$log\, p_t = log\, \Psi + \alpha\, log\, \Theta_t^u \tag{40}$$

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 states.[21] 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

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

equation with one unknown that can be solved for the aggregate efficiency in both steady states.

Table 6: Policy response of the aggregate matching efficiency

	$\Delta\psi^a$	η	$\Delta(a-b)$	Joint Effects
Ψ	-0.21	3.81	-0.39	1.39

Table 6 shows that aggregate matching efficiency in our model simulation increased by 1 percent after the Hartz reforms.[22] 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 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

[22]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)

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: Increased public matching efficiency

Counterfactual	(1)	(2)
	$\Delta log\, \psi_1^a = 0.01$	$\Delta log\, \psi_2^a$=0.29
Unemployment	-0.00	-0.07
Vacancy Share	0.57	12.12
Matching Share	0.14	3.04

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 29 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 (0.07 percentage points).

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. 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. 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.

Our results offer important economic policy lessons for other countries. Even though the Federal Employment Agency's direct intermediation activity was not key for the German labor market upswing, a reformed agency in its role as activator of unemployed workers can contribute substantially to reducing unemployment.

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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). These recommendations 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 p_t^a. The worker himself can not get in contact with two vacancies since he only searches through one channel. The worker can get in a situation, where he gets in contact with a vacancy which has a second contact from the private search market. Since firms always choose the agency contact if they have a double match this does not reduce the matching probability of a worker who only search via the agency.

If a worker uses the private search market his probability of making a match through the private market is:

$$\frac{c_t^p - q_t^p q_t^a}{u_t} = \frac{c_t^p - q_t^a \frac{c_t^p}{v_t} v_t g_t}{u_t} = p_t^p - g_t q_t^a p_t^p$$

If a worker gets in contact with a vacancy through the private market and this vacancy made a second contact through the public search channel, the worker will not be matched since firms prefer agency contacts. The probability that the worker himself makes two contact (one through each search channel) is not subtracted here since workers prefer private contacts over agency contacts. The worker probability of being matched through the agency thus has to be reduced to $p_t^a - p_t^a p_t^a$.

With these probabilities we can define the value of only searching through the agency as

$$S_t^a = p_t^a W_t^a + (1 - p_t^a) U_t^a \tag{41}$$

and the value of using both channels as

$$\begin{aligned} S_{it}^p = & - e_{it} + (p_t^a - p_t^a p_t^p) W_t^a + (p_t^p - g_t q_t^a p_t^p) W_t^p \\ & + (1 - (p_t^a - p_t^a p_t^p) - (p_t^p - g_t q_t^a p_t^p)) U_t^p \end{aligned} \tag{42}$$

The worker will only use both channels if the value from doing so is higher than the value of searching through the agency only.

$$S_{it}^p \geq S_t^a \Rightarrow S_{it}^p - S_t^a \geq 0. \tag{43}$$

The worker with the highest individual search cost who is still searching through the private market is indifferent between searching privately and not searching privately. Thus, for this worker equation 43 holds with equality. Using equations 41 and 42, we can derive the cutoff search costs:

$$\begin{aligned}\tilde{e}_{it} = & \left(p_t^a - p_t^a p_t^p\right) W_t^a + \left(p_t^p - g_t q_t^a p_t^p\right) W_t^p \\ & + \left(1 - \left(p_t^a - p_t^a p_t^p\right) - \left(p_t^p - g_t q_t^a p_t^p\right)\right) U_t^p - p_t^a W_t^a - \left(1 - p_t^a\right) U_t^a\end{aligned} \tag{44}$$

$$\begin{aligned}\tilde{e}_{it} = & - p_t^a p_t^p W_t^a + \left(p_t^p - g_t q_t^a p_t^p\right) W_t^p \\ & + \left(1 - \left(p_t^a - p_t^a p_t^p\right) - \left(p_t^p - g_t q_t^a p_t^p\right)\right) U_t^p - \left(1 - p_t^a\right) U_t^a\end{aligned} \tag{45}$$

Using

$$U_t^p - U_t^a = b - b^r, \tag{46}$$

we get equation 9 stated in the main text:

$$\tilde{e}_{it} = \left(1 - p_t^a\right)\left(b - b^r\right) + \left(p_t^p - g_t q_t^a p_t^p\right)\left(W_t^p - U_t^p\right) - p_t^a p_t^p \left(W_t^a - U_t^p\right) \tag{47}$$

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

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h\left(e_t\right) de_t. \tag{48}$$

The conditioned expected value of search costs is.

$$\widehat{e}_t = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h\left(e_t\right) de_t}{\xi_t}. \tag{49}$$

8.2 Firm

The probability of matching with a worker through the private search market is

$$\frac{c_t^p - q_t^a q_t^p f_t}{v_t} = q_t^p - q_t^a q_t^p g_t.$$

The probability of matching with a worker through the public search market is

$$\frac{c_t^a - p_t^a p_t^p u_t}{f_t} = \frac{c_t^a - c_t^a p_t^p \xi_t}{f_t} = q_t^a - q_t^a p_t^p \xi_t.$$

The representative firm solves the following maximization problem:

$$\max_{m_t^a, n_t^p, v_t, g_t} E_0 \sum_{t=0}^{\infty} \beta^t \{(a_t - w_t^p) n_t^p + (a_t - w_t^a) m_t^a - v_t^p (\kappa^p + \kappa^a g_t)\} \tag{50}$$

subject to the constraint:

$$n_t^p = (1-\phi) n_t^p + (1-\phi) m_t^a + v_t (q_t^p - q_t^a q_t^p g_t) \tag{51}$$

$$m_t^a = v_t g_t(q_t^a - q_t^a p_t^p \xi_t) \tag{52}$$

The corresponding Lagrangian is:

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

The first-order conditions are:

$$\frac{\delta L}{\delta m_t^a} = a_t - w_t^a - \lambda_t^a + E_t\beta(1-\phi)\lambda_{t+1}^p = 0 \tag{53}$$

$$\Rightarrow \lambda_t^a = a_t - w_t^a + E_t\beta(1-\phi)\lambda_{t+1}^p$$

$$\frac{\delta L}{\delta n_t^p} = a_t - w_t^p - \lambda_t^p + E_t\beta(1-\phi)\lambda_{t+1}^p = 0 \tag{54}$$

$$\Rightarrow \lambda_t^p = a_t - w_t^p + E_t\beta(1-\phi)\lambda_{t+1}^p$$

$$\frac{\delta L}{\delta v_t} = -(\kappa^p + g_t\kappa^a) + \lambda_t^a g_t(q_t^a - q_t^a p_t^p \xi_t) + \lambda_t^p(q_t^p - q_t^a q_t^p g_t) = 0 \tag{55}$$

$$\Rightarrow (\kappa^p + g_t\kappa^a) = \lambda_t^a g_t(q_t^a - q_t^a p_t^p \xi_t) + \lambda_t^p(q_t^p - q_t^a q_t^p g_t)$$

$$\frac{\delta L}{\delta g_t} = -v_t\kappa^a + \lambda_t^a v_t(q_t^a - q_t^a p_t^p \xi_t) - \lambda_t^p q_t^a q_t^p v_t = 0 \tag{56}$$

$$\begin{aligned}
&\Rightarrow \kappa^a = \lambda_t^a(q_t^a - q_t^a p_t^p \xi_t) - \lambda_t^p q_t^a q_t^p \\
&\Rightarrow \frac{\kappa^a + \lambda_t^p q_t^a q_t^p}{(q_t^a - q_t^a p_t^p \xi_t)} = \lambda_t^a
\end{aligned}$$

Substituting into first order condition for v_t:

$$(\kappa^p + g_t\kappa^a) = \frac{\kappa^a + \lambda_t^p q_t^a q_t^p}{(q_t^a - q_t^a p_t^p \xi_t)} g_t(q_t^a - q_t^a p_t^p \xi_t) + \lambda_t^p(q_t^p - q_t^a q_t^p g_t) \tag{57}$$

$$(\kappa^p + g_t\kappa^a) = \kappa^a g_t + \lambda_t^p q_t^a q_t^p g_t + \lambda_t^p(q_t^p - q_t^a q_t^p g_t)\kappa^p = q_t^p \lambda_t^p \frac{\kappa^p}{q_t^p} = \lambda_t^p \tag{58}$$

Substituting back into first-order conditions for g_t:

$$\frac{\kappa^a + \frac{\kappa^p}{q_t^p} q_t^a q_t^p}{(q_t^a - q_t^a p_t^p \xi_t)} = \lambda_t^a \tag{59}$$

$$\Rightarrow \frac{\kappa^a + \kappa^p q_t^a}{(q_t^a - q_t^a p_t^p \xi_t)} = \lambda_t^a$$

Plug into the FOCs for m_t^a and n_t^p:

$$\frac{\kappa^a + \kappa^p q_t^a}{(q_t^a - q_t^a p_t^p \xi_t)} = a_t - w_t^a + E_t \beta(1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{60}$$

$$\frac{\kappa^p}{q_t^p} = a_t - w_t^p + E_t \beta(1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{61}$$

8.3 Wage Bargaining

A worker's expected value of a match via the private market is:

$$\begin{aligned} W_t^p &= w_t^p + \beta(1-\phi) E_t W_{t+1}^p \\ &+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\ &+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right] \end{aligned} \tag{62}$$

U_t^p is the average value of being unemployed after having used the private market:

$$\begin{aligned} U_t^p = b + \beta E_t \xi_{t+1} &\left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\ &+ \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right] \end{aligned} \tag{63}$$

A worker's expected value of a match via the employment agency:

$$\begin{aligned} W_t^a &= w_t^a + \beta(1-\phi) E_t W_{t+1}^p \\ &+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\ &+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right] \end{aligned} \tag{64}$$

U_t^a is the average value of being unemployed after having used the agency only (and not the private market):

$$U_t^a = b^r + \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p \right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p \right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p \right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p \right) \end{array} \right) U_{t+1}^p \end{array} \right] \tag{65}$$
$$+ \beta E_t \left(1 - \xi_{t+1} \right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a \right) U_{t+1}^a \right]$$

A firm's value of a matched job depends on whether the match was established via the private market J_t^p or the agency J_t^p:

$$J_t^p = a_t - w_t^p + \beta E_t \left(1 - \phi \right) J_{t+1}^p, \tag{66}$$

$$J_t^a = a_t - w_t^a + \beta E_t \left(1 - \phi \right) J_{t+1}^p, \tag{67}$$

The Nash bargaining problem can be written as for workers that matched via the agency:

$$w_t^a \in argmax \left(W_t^a - U_t^a \right)^\gamma \left(J_t^a \right)^{1-\gamma}, \tag{68}$$

which results in the following sharing rule:

$$\gamma J_t^a = (1-\gamma)(W_t^a - U_t^a). \tag{69}$$

Equivalently, the Nash bargaining problem for workers that matched via the private market is:

$$w_t^p \in argmax \left(W_t^p - U_t^p \right)^\gamma \left(J_t^p \right)^{1-\gamma}, \tag{70}$$

which results in the following sharing rule:

$$\gamma J_t^p = (1-\gamma)(W_t^p - U_t^p). \tag{71}$$

The term on the right hand side includes

$$W_t^p - U_t^p = w_t^p - b + \beta(1-\phi) E_t W_{t+1}^p$$
$$- \beta \left(1 - \phi \right) E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p \right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p \right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p \right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p \right) \end{array} \right) U_{t+1}^p \end{array} \right] \tag{72}$$
$$- \beta \left(1 - \phi \right) E_t \left(1 - \xi_{t+1} \right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a \right) U_{t+1}^a \right]$$

for the private wage and

$$
\begin{aligned}
W_t^a - U_t^a =& w_t^a - b^r + \beta(1-\phi)E_t W_{t+1}^p \\
& - \beta\left(1-\phi\right)E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
& - \beta\left(1-\phi\right)E_t\left(1-\xi_{t+1}\right)\left[p_{t+1}^a W_{t+1}^a + \left(1-p_{t+1}^a\right)U_{t+1}^a\right]
\end{aligned}
\tag{73}
$$

for the agency wage. The two terms can be write in a compact way using the definition of the variable V_{t+1}

$$
\begin{aligned}
V_{t+1} =& W_{t+1}^p - \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
& - \left(1-\xi_{t+1}\right)\left[p_{t+1}^a W_{t+1}^a + \left(1-p_{t+1}^a\right)U_{t+1}^a\right]
\end{aligned}
\tag{74}
$$

such that

$$
W_t^a - U_t^a = w_t^a - b^r + \beta(1-\phi)E_t V_{t+1} \tag{75}
$$

and

$$
W_t^p - U_t^p = w_t^p - b + \beta(1-\phi)E_t V_{t+1}. \tag{76}
$$

Combining these expressions with the sharing rules 69 and 71 as well as the firms values 67 and 66 we get the wage equations stated in the main text

$$
w_t^p = \gamma a_t + \left(1-\gamma\right)b + \beta E_t\left(1-\phi\right)\left(\gamma J_{t+1}^p - \left(1-\gamma\right)V_{t+1}\right), \tag{77}
$$

$$
w_t^a = \gamma a_t + \left(1-\gamma\right)b^r + \beta E_t\left(1-\phi\right)\left(\gamma J_{t+1}^p - \left(1-\gamma\right)V_{t+1}\right). \tag{78}
$$

9 Appendix C: Details on Bargaining

Figure A1 shows the model assumptions and implication on the out-of-equilibrium outcomes for bargaining. Workers receive a lower starting wage if they are matched via the public employment agency than via the private channel.

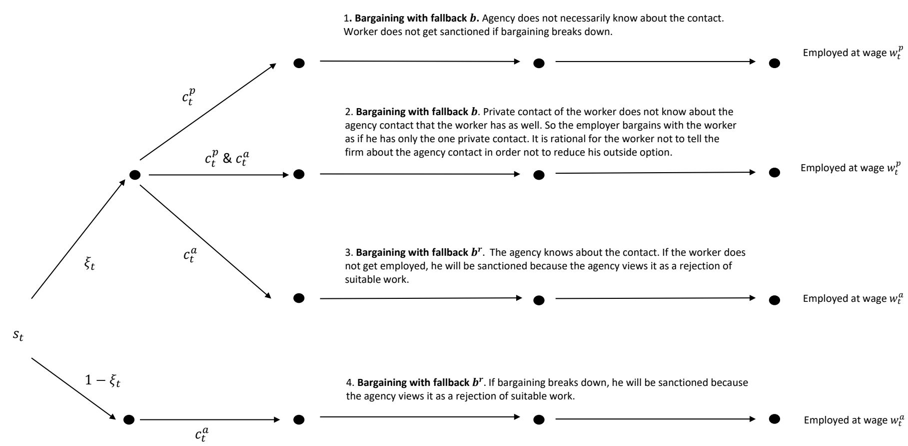

Figure A1: Stylized bargaining outcomes.

10 Appendix D: Data and Further Empirical Facts

10.1 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 30,000 individuals. For further descriptions of the GSOEP, see Goebel et al. (2019). Since we use 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 for 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 into account the possibility that the employment started in the year before the questionnaire. 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 contains 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 A2. The time series in figure A4 is based on the same adjustments. Additionally information of the GSOEP spell data is used to get the information in which month unemployment spells end. 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. It was carried out for the first time in the year 1989 and covers up to around 14,000 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 labor market tightness. The number of unemployed as well as the the data on the job finding rates are from the Integrated Labour Market Biographies (vom Berge et al. 2013). For more details see Appendix B in Hochmuth et al. (2021).

10.2 Vacancy and Matching Share: Robustness

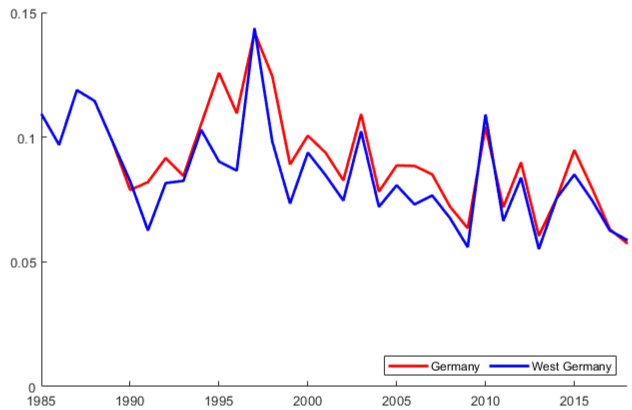

Figure A2: Matching Share. The figure shows the matching share of the agency based on GSOEP for a longer time period. As described in section 10.1, not all adjustments were possible.

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.

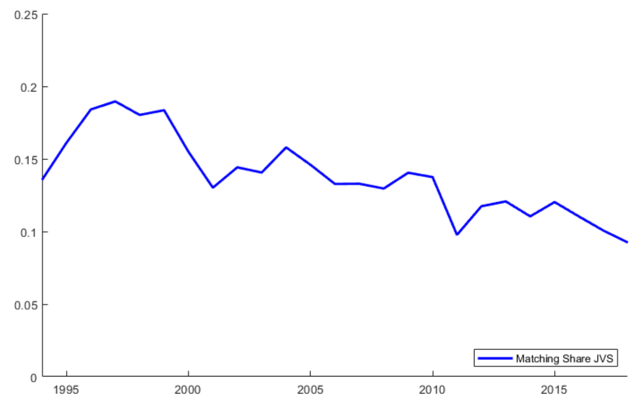

Figure A3: Matching Share. The figure shows the matching share of the agency based on IAB JVS.

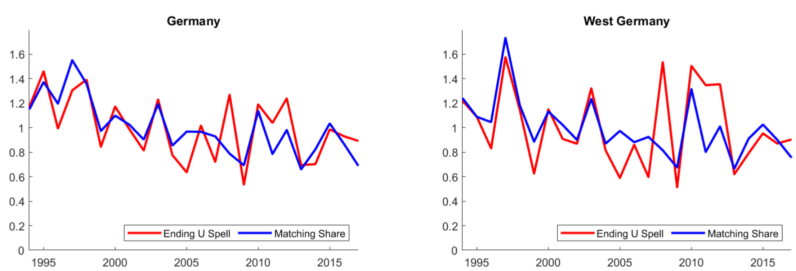

Figure A4: The figure shows the matching share based on all observations in blue and the matching share that is restricted to observation where an unemployment spell ended in the month of the match or the month before in red. Both time series are normalized to a mean of one. On average the restricted matching share was roughly 5 percentage points lower for Germany and 2.5 percentage points lower for West Germany in the post reform period.

10.3 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 16.

10.4 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					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.