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Public Employment Agency Reform, Matching Efficiency, and German Unemployment

Abstract

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 in 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-Codes: E240, E000, E600.

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

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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, Hutter et al. 2022), 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 or another channel. 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 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 the 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 Agency increased its market share of vacancies, the share of intermediated jobs dropped after the Hartz reform (both in the employer and household surveys). 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

[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 reforms, in particular Hartz III, see Appendix A.

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 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 addition, we show that there is a large role for a match surplus increase in terms of the decline in aggregate unemployment, which is at least partly related to the reform of long term unemployment benefits (Hartz IV).

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 search costs to search in the private market, 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 are also posted at the Federal Employment Agency. Nevertheless, the share of jobs that are intermediated via the PEA drops in a boom, as the share of searching workers that uses the private search market increases. At the same time, the overall number of searching workers decreases in a boom. Because of workers' search behavior, 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 (SOEP) and the IAB-Job Vacancy Survey, we find that the vacancy share is procyclical (i.e., it increases in booms), while the matching share is countercyclical. Given that we match the cyclicality properly, this puts us in 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 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

[3] Our model shows important similarities to Pissarides (1979) setup. However, there are also important differences. Workers' search decisions are 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 benefit shifts on wage bargaining outcomes. Moreover, we analyze the dynamic adjustment path of our labor market in response to business cycle shocks.

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, this measure 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 modelling, 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 in unemployment complements a broad microeconometric 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 stimulate private job search. By contrast, improved public job intermediation was unimportant for the decline in 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 in unemployment due to better public intermediation would require implausibly large increases in 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 better intermediation of jobs via the agency.

Furthermore, our counterfactual exercise reveals that the patterns found in the data are in line with a large positive shock to the bilateral surplus of work.

This surplus shock may either be driven by an increase in aggregate production or lower unemployment benefits. The latter is in line with the Hartz IV labor market reform that reduced unemployment benefits for long-term unemployed (see Section 2). While large macroeconomic effects of the Hartz IV labor market reform would be in line with the recent literature on this issue (e.g. Hochmuth et al. (2021), Klein & Schiman (2022), Hartung et al. (2022), Price (2018)), our identification approach can only establish an upper bound for the effects of the surplus shock on the job-finding rate. We are unable to distinguish the role of Hartz IV relative to other potential explanations (e.g. an increase in net exports due to Chinese demand for German goods).

The rest of the paper proceeds as follows. Section 2 provides details on the Hartz labor market reforms and their macroeconomic evaluation in the existing literature. Section 3 shows empirical facts on the role of the Federal Employment Agency in the matching market. Section 4 derives a novel theoretical model. Section 5 presents the calibration strategy. Section 6 shows results and counterfactual exercises.

2 German Labor Market Reforms and Macroeconomic Evaluation

Starting in 2003, the so called Hartz labor market reforms were implemented in Germany. In this section, we describe institutional details of the third and fourth reform steps in 2004 and 2005 (Hartz III and Hartz IV).[4] In addition, we review the literature on the macroeconomic effects of these two reform steps.

Hartz III changed the organizational structure of the Federal Employment Agency. Jacobi & Kluve (2007) write that before the Hartz reforms the Federal Employment Agency was considered as an inefficient institution that rarely implemented any sanctions in response to a lack of (search) activity or cooperation by unemployed workers. Hartz III changed the Federal Employment Agency's structure: "The formerly hierarchically organised employment offices are to be converted into customer-orientated one-stop-centres. (...) The caseload of caseworkers is targeted to be reduced and every job seeker is assigned to a particular case worker." (Jacobi & Kluve (2007), p. 51). In addition, the Federal Employment Agency started to use sanctions: "An unemployed individual will be threatened with sanctions in the form of temporary benefit reductions if he or she deviates from the integration agreement or does not cooperate appropriately." (Jacobi & Kluve (2007), p. 53)

Hartz IV was a reform of the unemployment benefit system for long-term unemployed. While these received earnings-dependent benefits before the reform, after the reform they had to apply for means-tested benefits that were no longer dependent on prior earnings (see section 2 in Hochmuth et al. (2021) for details). There is agreement that the unemployment benefit system for long-term unemployed became less generous due to Hartz IV. However, there

[4] See Appendix A for further institutional information and details on the other reform steps.

is disagreement about the quantitative decline of the replacement rate (Launov & Wälde (2013), Krebs & Scheffel (2013), and Krause & Uhlig (2012)). This is mainly due to heterogeneous effects depending on prior earnings, family status, and wealth (due to the means test).

How are these two reform steps evaluated in the macroeconomic literature? There is complete agreement in the macroeconomic literature that aggregate matching efficiency increased in the aftermath of the Hartz reform (e.g., Klinger & Rothe (2012), Hertweck & Sigrist (2013), Gartner et al. (2019), and Stops (2016), Gehrke et al. (2019), Hutter et al. (2022)). However, the structural analysis of the macroeconomic effects of the Hartz III reform is scarce. As a notable exception, Launov & Wälde (2016) use an indirect inference approach to match the increase of matching efficiency from a matching function estimation. However, in contrast to our paper, their model does not distinguish between the agency market and the private market.

There is a large literature on the macroeconomic effects of the Hartz IV labor market reforms. Early papers (Launov & Wälde (2013), Krebs & Scheffel (2013), and Krause & Uhlig (2012)) show a wide range of simulation results for the macroeconomic effects of Hartz IV (in between 0.1 percentage points in Launov & Wälde (2013) and 2.8 percentage points in Krause & Uhlig (2012)). The large differences are mainly due to different assumed average decline of the aggregate replacement rate for long-term unemployed (due to a very heterogeneous decline for different subgroups, see above). As it is difficult to resolve the disagreement on the exact decline of the replacement rate due to Hartz IV, the more recent literature developed other identification approaches. Hochmuth et al. (2021) disentangle the job-finding rate into a two-stage matching process. They use the IAB Job Vacancy Survey to discipline the quantitative effects for partial and equilibrium effects, yielding a roughly two percentage points decline in unemployment. Roughly half of it is driven by the partial effect and the equilibrium effect.[5] Hartung et al. (2022) use administrative data to quantify the effects of the Hartz IV reform on endogenous separations. They find a substantial macroeconomic effect due to this channel. Based on time series methods, Klein & Schiman (2022) show that structural wage shocks (potentially connected to Hartz IV) lead to an aggregate decline of unemployment of 3.5 percentage points. These more recent pieces of evidence all point to a large role of the Hartz IV reform on unemployment.

3 Empirical Results

This section first establishes new empirical facts for the role of the Federal Employment Agency in job intermediation before and after the Hartz labor market reforms. Second, it analyzes whether the movement of the matching share could be driven by a general time trend. Third, it illustrates how the usage of private search channels changed around the time of the Hartz reforms.

[5] The size of the partial effect is supported by microeconometric evidence by Price (2018).

3.1 Vacancy and Matching Shares over Time

We start by showing 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 (Bossler, Gürtzgen, Kubis, Küfner & Lochner 2020), which is an annual representative cross-sectional firm survey. We calculate the matching share based on the German Socioeconomic Panel (SOEP) (Goebel et al. 2019), which is an annual household survey.[6]

Figure 1 shows the aggregated vacancy share from 1993 to 2018.[7] 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

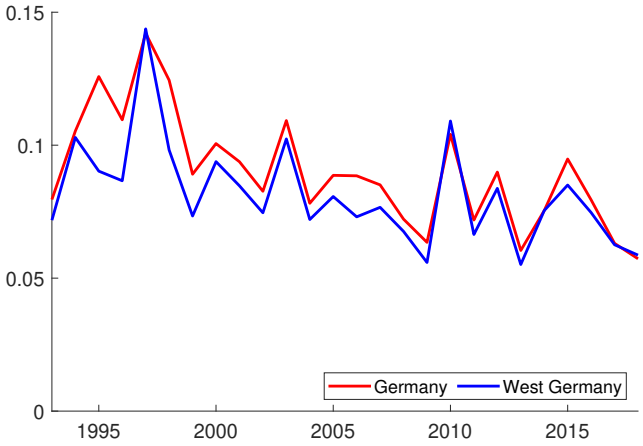
Note: This figure shows the share of vacancies that was registered at the Federal Employment Agency based on the IAB Job Vacancy Survey.

Figure 2 shows the matching share from 1993 to 2018 based on the SOEP. 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. For comparability reasons, we show Figures 1 and 2 for the same time episode.

[6] 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.

[7] See Appendix 12.1 for details on the chosen baseline observation period and the calculation of vacancy and matching shares.

Figure 2: Matching Share



Note: This figure shows the share of matches that was intermediate via the Federal Employment Agency based on the SOEP. More details can be found in Section 12.1.

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 SOEP (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 (see Figure A2 in the Appendix for a visual inspection of different education groups over time). 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 SOEP) and find a statistically significant negative effect. See Table A5 in the Appendix.

Given these results for different skill groups at the aggregate level and the microeconometric results, 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.[8]

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)

[8] In Table A3, 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.

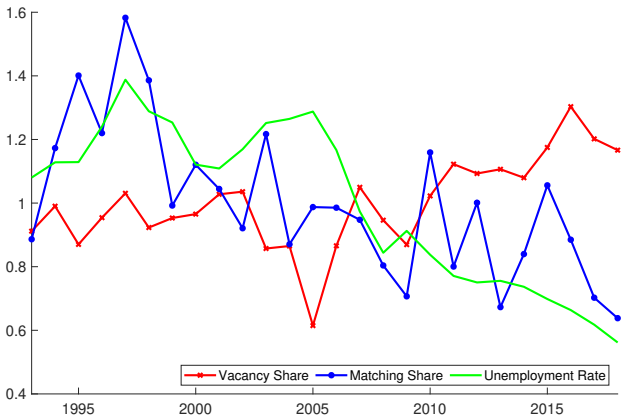
Table 1: Matching Shares according to Qualification

Matching Share	Pre Reform	Post Reform	Difference
Germany			
Low	0.111	0.082	-0.029
Medium	0.120	0.097	-0.023
High	0.050	0.033	-0.017
West Germany			
Low	0.096	0.078	-0.018
Medium	0.106	0.089	-0.017
High	0.048	0.031	-0.017

Note: Calculations are based on SOEP. 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 university degree respectively. The table shows the average matching shares before and after the year 2004. Individuals are weighted with the cross-sectional weights.

who find that the number of recruitment channels used by firms is procyclical. The correlation between the matching share and unemployment is 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 procyclicality of the vacancy share and the countercyclicality of the matching share.

Figure 3: Business Cycle: Vacancy Share, Matching Share, and Unemployment



Note: The figure shows vacancy share, matching share, and unemployment. In order to make comovements better visible, all variables are normalized such that they are one on average.

3.2 Matching Share: Time Trend vs. Reform Shift

Figure 2 shows a sluggish downward movement of the matching share. This is unsurprising, as the implementation of the restructuring of the Federal Employment Agency reform took almost two years. Holzner & Watanabe (2021) write that the roll-out in the local employment agencies started in early 2004 and ended in late 2005.

The visual inspection of Figure 2 may suggest that there is a long-run downward trend of the matching share before the Hartz reforms that we capture when we look at averages of the matching share before and after the reform. We address this issue in several ways.

First, we estimate a linear time trend prior to the reform (up to 2003). We indeed obtain a negative time trend. However, the estimated time trend is economically very small and statistically insignificant. When we nevertheless extrapolate this time trend beyond the Hartz reforms, the decline of the matching share (net of the trend) in the aftermath of the Hartz reforms is 1.5 and 1.6 percentage points for Germany and for West Germany. In other words, there remains a significant downward shift that is unexplained by the time trend.

Figure 4: Longer Time Period: Matching Share and Unemployment Rate

Note: The figure shows the matching share and the unemployment rate for a longer time period (West Germany) and prior to the Hartz reforms.

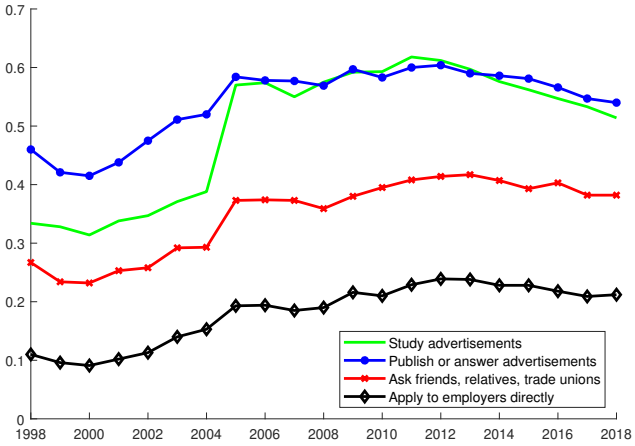
Second, the lack of statistical significance of the time trend in the prior exercise may be due to the short observation period. When we use the maximum time duration from 1985-2003 based on SOEP, there is again no statistically significant time trend. Figure 4 illustrates the positive comovement of the matching share with unemployment. The period of high unemployment in the mid-90s is associated with a larger matching share. This may be one of the reasons for the visual impression of a negative time trend with the shorter observation period (starting with the labor market downswing after German unification). When we use the longer pre-reform period, the average drop of the matching share is 2.1 percentage points for West Germany (i.e. similar to the baseline).

It is worthwhile emphasizing that we use the non-detrended time series in

our model matching exercise.[9] First, in none of our of scenarios (short vs. long time series, Germany or West Germany), we found a statistically significant time trend. Second, as we will show below, our theoretical model will be able to replicate the positive comovement between unemployment and matching share. Thus, to the extent that shocks or policy interventions reduced unemployment, this will be associated with a decline of the matching share (i.e. as an endogenous model outcome and not a trend shift).

The described aggregate shifts of the matching share can certainly not be interpreted causally. However, there is complementary causal microeconometric evidence by Holzner & Watanabe (2021). They use the staggered roll-out period of the Hartz III reform and show that "the Hartz 3 reform decreased the fraction of newly unemployed receiving vacancy referrals significantly from the 1st quarter onward" (p. 19). They argue that this was part of the new strategy of the Federal Employment Agency: "After the reform the goal to match registered vacancies was disrated and the goal to bring unemployed back into work uprated." (p. 12.) The results by Holzner & Watanabe (2021) are complemented by our microeconometric estimations in the Appendix (see Table A5) that show that the probability of being matched via the agency declined after the Hartz reform. While Holzner & Watanabe (2021) provide causal microeconometric evidence, our paper provides complementary macroeconomic simulation results to quantify the macroeconomic impact of Hartz III.

Figure 5: Use of Private Search Channels



Note: The figure shows the share of unemployed workers in Germany who use the depicted private channels (for the four most important private channels). Source: European Union Labor Force Survey, Eurostat.

[9] In time series regressions, in contrast to the time trend, the permanent downward shift of the matching share in the aftermath of the Hartz reforms is always statistically significant at the 1 percent level (for the short and long time series as well as for West Germany and for Germany as a whole.)

3.3 Descriptive Evidence on Private Search Channels

Given the documented decline of the Federal Employment Agency's matching share, we expect an increase of private search activity around the time of the labor market reform. To analyze this issue, we use the European Union Labor Force Survey for Germany. Figure 5 shows the four most important private search channels from 1998 to 2018.[10] The share of unemployed workers who use these search methods went up around the time of the reform. The share of those who "publish or answer advertisements" increased for example by around 10 percentage points around the time of the reform. The share of those who "study advertisements" went up by more than 20 percentage points. This is further (anecdotal) evidence that search in the German labor market changed at the time of the Hartz reforms. Obviously, these search methods were also affected by other reform steps such as the less generous long-term unemployment benefits due to Hartz IV. To get further insights about the role of different reform steps, we will present a structural model that allows us to match several macroeconomic targets.

4 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.

4.1 Search Markets

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

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

[10] This survey is only available from 1998 onwards. We do not use the SOEP, as search behavior was only asked for a limited number of years and the relevant question changed over time.

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 of 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

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

4.2 Search Decision: Households

Households always search via the agency. This is motivated by empirical facts. Franz (2013, p.231) shows for Germany that 97% of unemployed workers used the Federal Employment Agency for their job search. Keep in mind that registered unemployed are required to get in contact with the Federal Employment 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 to search privately. The household with the highest search costs 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 of search for a worker who uses both the agency and the private search channel is defined as follows:

$$S_{it}^p = -e_{it} + (p_t^a - \chi_t) W_t^a + (p_t^p - \omega_t)\, W_t^p + (1 - (p_t^a - \chi_t) - (p_t^p - \omega_t))\, U_t^p, \tag{8}$$

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 to match through one of the two channels and the expected returns. Note that the contact-finding rates need to be adjusted by the terms χ_t and ω_t to obtain the corresponding realized matching probabilities. Workers and vacancies can make two contacts because of the two existing search channels. In these cases, only one contact will result in a match. The assignment of worker and firm-sided double matches (χ_t and ω_t) depends on which sort of match is preferred by these two sides. We will answer this question after wage determination.

U_t^a and U_t^p are the average present values of unemployed workers after having used the agency and the private market respectively:

$$\begin{aligned} U_t^a = b^r + \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - \omega_{t+1}\right) W_{t+1}^p + \left(p_{t+1}^a - \chi_{t+1}\right) W_{t+1}^a + \\ \left(\ 1 - \left(p_{t+1}^p - \omega_{t+1}\right) - \left(p_{t+1}^a - \chi_{t+1}\right)\ \right) U_{t+1}^p \end{array} \right] \\ + \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right], \end{aligned} \tag{9}$$

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

$$\begin{aligned} U_t^p = b + \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - \omega_{t+1}\right) W_{t+1}^p + \left(p_{t+1}^a - \chi_{t+1}\right) W_{t+1}^a + \\ \left(\ 1 - \left(p_{t+1}^p - \omega_{t+1}\right) - \left(p_{t+1}^a - \chi_{t+1}\right)\ \right) U_{t+1}^p \end{array} \right] \\ + \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right]. \end{aligned} \tag{10}$$

A worker will use both channels if $S_{it}^p - S_t^a \geq 0$. Combining equations (7), (8), (9), and (10) yields the cutoff point, $\tilde{e}_t$, at which workers are indifferent between searching privately or not (see Appendix 9 for details):

$$\tilde{e}_t = (p_t^p - \omega_t)(W_t^p - U_t^p) - \chi_t (W_t^a - U_t^p) + (1 - p_t^a)(b - b^r), \qquad (11)$$

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. 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. 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.

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

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h(e_t)\, de_t, \qquad (12)$$

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

$$\widehat{e}_t = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h(e_t)\, de_t}{\xi_t}. \qquad (13)$$

4.3 Search Decision: Firms

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

$$g_t = \frac{f_t}{v_t}. \qquad (14)$$

Firms maximize intertemporal expected profits:

$$\max_{m_t^a, n_t^p, v_t, g_t} E_0 \sum_{t=0}^{\infty} \beta^t \{(a_t - w_t^p) n_t^p + (a_t - w_t^a) m_t^a - v_t(\kappa^p + \kappa^a g_t)\}, \qquad (15)$$

subject to the constraints:

$$n_t^p = (1-\phi)n_{t-1}^p + (1-\phi)m_{t-1}^a + v_t(q_t^p - \nu_t(g_t)), \tag{16}$$

$$m_t^a = v_t g_t (q_t^a - o_t). \tag{17}$$

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 through one channel are not equal to the corresponding contact-finding rates. The probability of matching through the private market is reduced by $\nu_t(g_t)$. The probability of matching through the agency is reduced by o_t. These terms capture that firms may find two workers for one vacancy if they use both search channels and that a worker may reject an offer because the worker made two contacts. The explicit functional forms of $\nu_t(g_t)$ and o_t will be derived after the splitting of double matches is determined.[11]

The profit 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):

$$\frac{\kappa^p}{q_t^p} = a_t - w_t^p + E_t\beta(1-\phi)\frac{\kappa^p}{q_{t+1}^p}, \tag{18}$$

$$\frac{\kappa^a + \frac{\kappa^p}{q_t^p}\nu_t'(g_t)}{q_t^a - o_t} = a_t - w_t^a + E_t\beta(1-\phi)\frac{\kappa^p}{q_{t+1}^p}. \tag{19}$$

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 are equal to 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 the probability of finding a worker through the agency is influenced by the splitting of double matches. In the numerator, firms take into account that they influence the number of double matches by registering more vacancies at the agency.

[11] For the derivations in this section, we postulate that ν_t is a function of g_t of the type $\nu_t = x_t g_t$ where x_t is not yet determined and that o_t does not depend on g_t. Both will be verified later.

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 equal the expected returns of just posting a private vacancy.

4.4 Wage Bargaining

For the search decision (see Section 4.2), we assumed that searchers may 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 10 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 is 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.

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

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

where ϕ is the exogenous separation rate.

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

$$
\begin{aligned}
W_t^p = w_t^p &+ \beta(1-\phi)E_t W_{t+1}^p \\
&+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - \omega_{t+1}\right) W_{t+1}^p + \left(p_{t+1}^a - \chi_{t+1}\right) W_{t+1}^a \\ + \left(1 - \left(p_{t+1}^p - \omega_{t+1}\right) - \left(p_{t+1}^a - \chi_{t+1}\right)\right) U_{t+1}^p \end{array} \right] \\
&+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a\right].
\end{aligned} \tag{21}
$$

The expected values of a matched via the agency and the private sector for a firm are:

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

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

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

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

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

where γ is the bargaining power of the workers.

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 $W_t^a - U_t^a$

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

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

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

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

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 were matched through the agency. This is in line with empirical evidence by Holzner & Watanabe (2021) that vacancy referral via the agency leads to lower wages.

Incumbent workers all have the same fallback option. Therefore, they earn the same as workers that are matched via the private market.

4.5 Aggregation

In terms of aggregation, we have to take into account that not each contact results in a match. Given that a share of searching workers ξ_t uses both the public and the private search channel, some workers may receive two job offers, but they 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. In the previous subsection, we have shown that a worker who is matched via the private market earns a higher wage than a worker who is matched via the agency (due to a different outside option). This provides a rationale on how firms and workers behave if they made two contacts and thus gives us the functional forms of χ_t, ω_t, o_t and $\nu_t(g_t)$.

Conditional on searching privately, the probability of finding a new job through the agency was adjusted by χ_t on the worker side. Since $w_t^a < w_t^p$, a firm prefers an agency contact over a private contact. For the same reason a worker prefers a private contact over an agency contact. Thus, conditional on searching privately, the probability that an agency contact of a worker does not lead to a new match is the probability that this worker has a private contact at the same time:

$$\chi_t = p_t^a p_t^p. \tag{29}$$

The probability that a privately searching worker matches through the private search market is adjusted by ω_t. Here the possibility is taken into account that a privately searching worker makes a contact with a firm that made an agency contact at the same time. The firm then prefers the agency contact, such that

$$\omega_t = g_t q_t^a p_t^p. \tag{30}$$

Similarly, we have to define the relevant assignment of double matches for the firm side. If a firm makes an agency contact the respective worker may have a private contact at the same time, which he prefers over the agency contact, which gives us

$$o_t = q_t^a p_t^p \xi_t. \tag{31}$$

Finally, the probability that a firm finds a new worker through the private market was adjusted by $\nu_t(g_t)$. Because of the described wage differences, a firm prefers an agency contact over a private contact, while a worker prefers private contact. Thus, the necessary adjustment is

$$\nu_t(g_t) = q_t^a q_t^p g_t. \tag{32}$$

Double matches also have to be deducted when calculating the aggregate number of matches, m_t, which is defined as:

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

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

$$p_t = m_t / s_t, \tag{34}$$

$$q_t = m_t / v_t. \tag{35}$$

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.[12]

$$m_t^a = c_t^a - p_t^p p_t^a u_t. \tag{36}$$

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):

$$m_t^p = c_t^p - q_t^p q_t^a f_t. \tag{37}$$

Now we can define the matching share of the agency as

$$Q_t = \frac{m_t^a}{m_t}. \tag{38}$$

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

$$n_t = m_t^a + n_t^p, \tag{39}$$

where n_t^p is

$$n_t^p = (1-\phi) n_{t-1}^p + (1-\phi) m_{t-1}^a + m_t^p. \tag{40}$$

The number of searching workers, privately searching workers and unemployed are:

$$s_t = 1 - n_{t-1} + \phi n_{t-1}, \tag{41}$$

$$u_t = \xi_t s_t, \tag{42}$$

$$s_t^u = 1 - n_{t-1}. \tag{43}$$

Equation (39) aggregates agency matches and all existing matches (plus new private matches),[13] defined in equation (40), the law of motion for employment.

[12] 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.

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

We assume that newly unemployed workers can be immediately rehired. Thus, equation (41) gives the number of job seekers. Given the share of active searching job seekers ξ_t, their level is determined by equation (42). The number of unemployed is given by equation (43).

5 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 $b^r = 0.59$.[14]

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).[15] 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.

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	SOEP
ξ	Private searchers	0.68	SOEP
s^u	Unemployment	0.09	BA[16]
p	Job finding rate	0.09	Literature[17]
Δs^u	Unemployment	-0.02	BA
Δg	Vacancy share	0.02	IAB JVS
ΔQ	Matching share	-0.02	SOEP

Note: The table shows the pre-reform calibration targets (upper part) and the targeted reform changes (lower part).

[14] 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.

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

[16] Federal Employment Agency (2020), Bundesagentur in German, BA in short.

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

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

Note: The table shows the parameter values.

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.[18] For this purpose, we set α_a and α_p.[19] 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 (see lower part of Table 2). For this purpose, we use three policy changes to hit three targets. First, we allow for a different matching efficiency of the PEA, $\Delta\psi^a$ (similar to Launov & Wälde (2016)). 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

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

[19] 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.

at private employers and/or it may have sanctioned workers that do not fulfil certain search requirements (see Section 2). 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 in unemployment and a reduction of PEA's vacancy share and matching shares. Third, we allow for a different joint match surplus, $a - b$. The larger joint surplus may either be triggered by a reduction of unemployment benefits or an increase in aggregate productivity. The Hartz IV reform reduced unemployment benefits for long-term unemployed (see Section 2). In addition, Germany faced a substantial business cycle upswing and increase in 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 private search channels and firms are more likely to post vacancies at the PEA. The latter effect leads to an increase in 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

	$\Delta\psi^a$	$\Delta\eta$	$\Delta(a-b)$
Unemployment	-	-	-
Vacancy Share	+	-	+
Matching Share	+	-	-

Note: The table shows the sign of responses to an increase in PEA's contact efficiency, ψ^a, to activation, η, and to an increase of the surplus, $a - b$.

As Table 4 shows, all three policy exercises lead to a reduction in 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 shock.

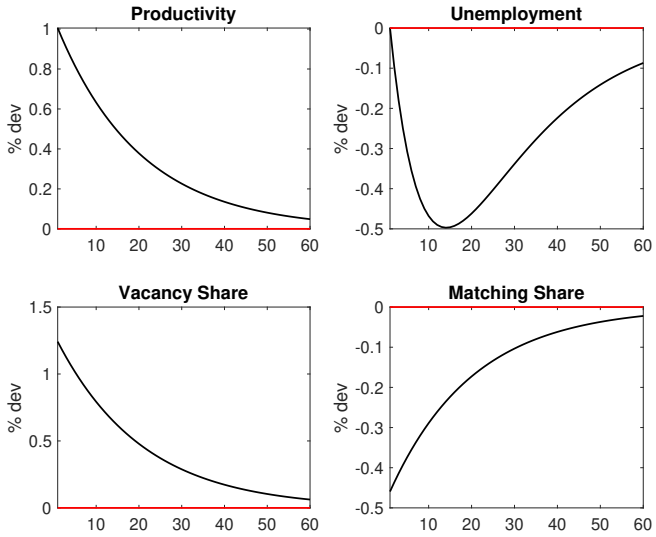
6 Results

6.1 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 aggregate productivity shocks that are in line with the presented facts in Section 3. In addition, it allows us to convey an intuition for the underlying model mechanism.

Figure 6 shows impulse response functions in response to a positive aggregate productivity shock (i.e. a positive joint surplus shock). As usual in the search and matching model, this shock increases firms' vacancy posting, increases workers' job-finding rate, and thereby reduces unemployment.

Figure 6: IRFs: Aggregate Productivity Shock



Note: This figure shows impulse response functions in reaction to a positive one percent aggregate 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 PEA. 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 3). 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.

6.2 Disentangling the Reform Effects

In our matching exercise, we target three outcome variables from the data (decline of unemployment, increase of vacancy share, and decline of matching share: see Section 5) with three policies (changed public matching efficiency, activation policies, and different surplus). Table 5 shows the results of our matching exercise. Jointly, these 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.[20]

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

Note: This table shows the joint (matched) effects of all three policy exercises (last column). The other columns show the individual effect of each exercise separately. $\Delta\psi^a$ represents the change of public matching efficiency, $\Delta\eta$ is activation, and $\Delta(a-b)$ is the change of the joint surplus. All changes are in percentage points.

According to our matching exercise in Table 5, the matching efficiency of the Federal Employment Agency fell after the Hartz reforms. Two 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 public matching efficiency to be a key driver for the reduction of unemployment. Second, in Table A4 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 in public matching efficiency. The estimated change of public matching efficiency after the Hartz 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. With activation policies, the PEA uses stick and carrot to activate unemployed workers' private search activities. This leads to a decline in unemployment, without increasing the matching efficiency parameters.

Finally, we show that the increase of the joint surplus from work/production 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

[20] In contrast to Coe & Snower (1997), we do no have policy complementarities. See Appendix for a different sequencing of reforms.

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).

6.3 Putting our Quantitative Results in Perspective

Our counterfactual results suggest that the Federal Employment Agency became less important/effective as job intermediary. However, it became more important in terms of improved activation policies. In addition, a joint surplus shock reduced unemployment. In this subsection, we will compare our structural shocks to the actual reform changes and we will embed our results in the macroeconomic and microeconometric evaluation literature.

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 in vacancy referrals. In our counterfactual exercise, the agency's matching efficiency drops by $\Delta\psi^a/\psi^a = -4.51\%$. Although this number is difficult to compare to Holzner & Watanabe (2021), Figure 6 in their paper shows a decline in vacancy referrals as a causal effect of the introduction of the Hartz III reform. Furthermore, we show that our result that the agency as an intermediary cannot be a key driver for the decline of unemployment is very robust (see Section 6.5).

The aggregate reduction of unemployment due to Hartz III is in line with Launov & Wälde (2016) who argue that this reform step 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. In our structural exercise $\Delta\eta = 0.07$, corresponds to a 12 percent decline of benefits in case of a sanction. How does this compare to actual sanctions? Information on sanctions is only publicly available from 2007 onward (see Federal Employment Agency (2023)). Conditional on sanctioning, the Federal Employment Agency reduced benefits by on average 22 percent in between 2007 and 2019. Thus, the actual sanctioning appears larger than what we use in our model. However, it has to be kept in mind that workers who do not search privately have to be detected. Against this background, the order of magnitude of sanctions in our matching exercise appears realistic.

Our finding complements a broad microeconomic literature from a macroeconomic perspective. The effects of sanctions on unemployment-to-employment transitions are widely documented. Hainmueller et al. (2016) exploit a pilot project for Germany. They show that local agencies (with the Federal Employment system in Germany) with a lower caseworker-to-clients ratio in-

creased monitoring, imposed more sanctions, and thereby reduced unemployment. There is plenty of evidence for other countries that caseworkers and sanctions matter (e.g. Abbring et al. (2005), Lalive et al. (2005), Schiprowski (2020), Svarer (2011)).

Finally, we found a substantial decline in unemployment due to the surplus shock. 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 a proxy for the business cycle and the strong increase of German net exports).

How does the decline of benefits in our counterfactual exercise ($\Delta(a-b) = 0.22$) compare to the actual reform of the benefit system? As explained in Section 2, the early macroeconomic literature on the Hartz IV reform (Krause & Uhlig (2012), Krebs & Scheffel (2013), Launov & Wälde (2013)) disagrees on the macroeconomic effects of the reform due to different assumed decline of the replacement rate for long-term unemployed. The decline of the replacement rate ranges from 7 percent (Launov & Wälde (2013)) to 67 percent for skilled workers (Krause & Uhlig (2012)). Given that our paper does not have a distinction between short- and long-term benefits, $\Delta(a-b) = 0.22$ appears to be on the upper end.

As the main focus of our paper is the Hartz III reform, this paper cannot provide a final answer on this issue. Instead, we establish an upper bound on how much the increase in the job-finding rate due to Hartz IV could have contributed to the decline of unemployment. In addition, 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 & Schiman (2022), Carrillo-Tudela et al. (2021)) and our Section 2.

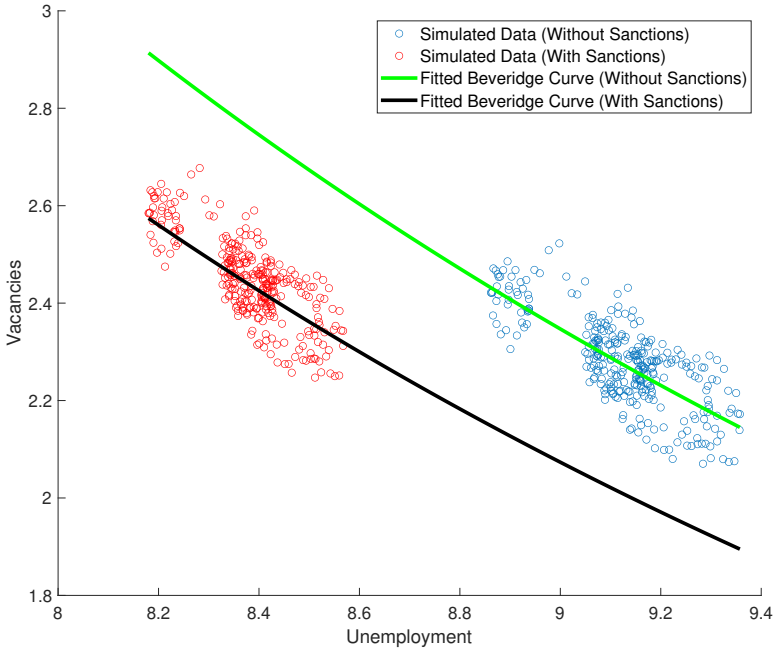
6.4 Activation Policies and Matching Efficiency

To illustrate the interaction between activation policies and aggregate matching efficiency, we simulate our model economy with a series of aggregate productivity shocks. Figure 7 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 (see, e.g., Klinger & Weber (2016)).

Through the lens of a standard search and matching function, a leftward shift of the Beveridge Curve is typically interpreted as an increase in 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

Figure 7: Beveridge Curve



Note: This figure shows simulated data (in response to productivity shocks) around a steady state with and without sanctions by PEA. It also includes fitted Beveridge Curves.

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:

$$log\, p_t = log\, \Psi + \alpha\, log\, \Theta_t^u \tag{44}$$

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 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

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

Note: This table shows how the aggregate backed-out matching efficiency (through the lens of a homogeneous matching function) responds to different policy interventions. The last column shows the joint effects of all three exercises. All changes are in percent.

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 in 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

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

[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)

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 done with a higher matching efficiency). Therefore, it is important to analyze the underlying structural forces at work.

6.5 Further Robustness Checks

One of the key contributions 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 an intermediary.

To check for the robustness of this result, we present two more counterfactual exercises that illustrate that the increase in 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 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 in the matching efficiency basically have close to zero effects on aggregate unemployment.

Table 7: Increased Public Matching Efficiency

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

Note: This table shows the implications for different quantitative increases of public matching efficiency. All changes are in percentage points

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 in unemployment through the Federal Employment Agency would require a very large increase in 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 in 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.

7 Conclusion

Our paper shows that the matching share of the Federal Employment Agency fell in the aftermath of the Hartz reforms, despite an increase in 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 in 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 an activator of unemployed workers can contribute substantially to reducing unemployment.

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8 Appendix A: Details on Hartz Reforms

8.1 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 reforms was "Fordern und Fördern," the so called principle of "rights and duties" (see Jacobi & Kluve (2007)). 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 the 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.

8.2 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 (2007) 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.

9 Appendix B: Model Derivations

This Appendix shows the detailed model derivations. As in the main part, we start with the household optimization, followed by the firm optimization and the derivation of wages.[23]

9.1 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 searches via the agency.

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

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

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 contacts (one through each search channel) is not subtracted here since workers prefer private contacts over agency contacts. The worker's 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

$$S_t^a = p_t^a W_t^a + (1 - p_t^a)\, U_t^a \tag{45}$$

and the value of using both channels as

$$\begin{aligned} S_{it}^p = &- e_{it} + (p_t^a - p_t^a p_t^p)\, W_t^a + (p_t^p - g_t q_t^a p_t^p)\, W_t^p \\ &+ (1 - (p_t^a - p_t^a p_t^p) - (p_t^p - g_t q_t^a p_t^p))\, U_t^p. \end{aligned} \tag{46}$$

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

[23] For expositional convenience, we use the splitting equilibrium rules for double matches from Section 4.5 throughout the Appendix.

$$S_{it}^p \geq S_t^a \Rightarrow S_{it}^p - S_t^a \geq 0. \tag{47}$$

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 (47) holds with equality. Using equations (45) and (46), we can derive the cutoff search costs:

$$\begin{aligned}\tilde{e}_{it} = &\left(p_t^a - p_t^a p_t^p\right) W_t^a + \left(p_t^p - g_t q_t^a p_t^p\right) W_t^p \\ &+ \left(1 - \left(p_t^a - p_t^a p_t^p\right) - \left(p_t^p - g_t q_t^a p_t^p\right)\right) U_t^p - p_t^a W_t^a - \left(1 - p_t^a\right) U_t^a\end{aligned} \tag{48}$$

$$\begin{aligned}\tilde{e}_{it} = &- p_t^a p_t^p W_t^a + \left(p_t^p - g_t q_t^a p_t^p\right) W_t^p \\ &+ \left(1 - \left(p_t^a - p_t^a p_t^p\right) - \left(p_t^p - g_t q_t^a p_t^p\right)\right) U_t^p - \left(1 - p_t^a\right) U_t^a\end{aligned} \tag{49}$$

Using

$$U_t^p - U_t^a = b - b^r, \tag{50}$$

we get equation (11) stated in the main text:

$$\tilde{e}_{it} = \left(1 - p_t^a\right)\left(b - b^r\right) + \left(p_t^p - g_t q_t^a p_t^p\right)\left(W_t^p - U_t^p\right) - p_t^a p_t^p \left(W_t^a - U_t^p\right). \tag{51}$$

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

$$\xi_t = \int_{-\infty}^{\tilde{e}_t} h\left(e_t\right) de_t. \tag{52}$$

The conditioned expected value of search costs is.

$$\widehat{e_t} = \frac{\int_{-\infty}^{\tilde{e}_t} e_t h\left(e_t\right) de_t}{\xi_t}. \tag{53}$$

9.2 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:

$$\max_{m_t^a, n_t^p, v_t, g_t} E_0 \sum_{t=0}^{\infty} \beta^t \{(a_t - w_t^p) n_t^p + (a_t - w_t^a) m_t^a - v_t^p(\kappa^p + \kappa^a g_t)\}, \tag{54}$$

subject to the constraints:

$$n_t^p = (1-\phi) n_{t-1}^p + (1-\phi) m_{t-1}^a + v_t(q_t^p - q_t^a q_t^p g_t), \tag{55}$$

$$m_t^a = v_t g_t (q_t^a - q_t^a p_t^p \xi_t). \tag{56}$$

The corresponding Lagrangian is:

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

The first-order conditions are:

$$\frac{\partial L}{\partial m_t^a} = a_t - w_t^a - \lambda_t^a + E_t \beta (1-\phi) \lambda_{t+1}^p = 0 \tag{57}$$

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

$$\frac{\partial L}{\partial n_t^p} = a_t - w_t^p - \lambda_t^p + E_t \beta (1-\phi) \lambda_{t+1}^p = 0 \tag{58}$$

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

$$\frac{\partial L}{\partial v_t} = -(\kappa^p + g_t \kappa^a) + \lambda_t^a g_t (q_t^a - q_t^a p_t^p \xi_t) + \lambda_t^p (q_t^p - q_t^a q_t^p g_t) = 0 \tag{59}$$

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

$$\frac{\partial L}{\partial g_t} = -v_t \kappa^a + \lambda_t^a v_t (q_t^a - q_t^a p_t^p \xi_t) - \lambda_t^p q_t^a q_t^p v_t = 0 \tag{60}$$

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

Substituting into first-order condition for v_t:

$$(\kappa^p + g_t\kappa^a) = \frac{\kappa^a + \lambda_t^p q_t^a q_t^p}{(q_t^a - q_t^a p_t^p \xi_t)} g_t(q_t^a - q_t^a p_t^p \xi_t) + \lambda_t^p (q_t^p - q_t^a q_t^p g_t) \tag{61}$$

$$\begin{aligned} (\kappa^p + g_t\kappa^a) &= \kappa^a g_t + \lambda_t^p q_t^a q_t^p g_t + \lambda_t^p (q_t^p - q_t^a q_t^p g_t) \\ \kappa^p &= q_t^p \lambda_t^p \\ \frac{\kappa^p}{q_t^p} &= \lambda_t^p \end{aligned} \tag{62}$$

Substituting back into first-order conditions for g_t:

$$\frac{\kappa^a + \frac{\kappa^p}{q_t^p} q_t^a q_t^p}{(q_t^a - q_t^a p_t^p \xi_t)} = \lambda_t^a \tag{63}$$

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

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

$$\frac{\kappa^a + \kappa^p q_t^a}{(q_t^a - q_t^a p_t^p \xi_t)} = a_t - w_t^a + E_t \beta(1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{64}$$

$$\frac{\kappa^p}{q_t^p} = a_t - w_t^p + E_t \beta(1-\phi) \frac{\kappa^p}{q_{t+1}^p} \tag{65}$$

9.3 Wage Bargaining

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

$$\begin{aligned} W_t^p = w_t^p &+ \beta(1-\phi) E_t W_{t+1}^p \\ &+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \right. \\ \left. - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \right) U_{t+1}^p \end{array} \right] \\ &+ \beta\phi E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]. \end{aligned} \tag{66}$$

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

$$\begin{aligned} U_t^p = b &+ \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \right. \\ \left. - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \right) U_{t+1}^p \end{array} \right] \\ &+ \beta E_t \left(1 - \xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]. \end{aligned} \tag{67}$$

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

$$\begin{aligned} W_t^a = w_t^a &+ \beta(1-\phi)E_t W_{t+1}^p \\ &+ \beta\phi E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \right. \\ \left. - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \right) U_{t+1}^p \end{array} \right] \\ &+ \beta\phi E_t \left(1-\xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]. \end{aligned} \tag{68}$$

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

$$\begin{aligned} U_t^a = b^r &+ \beta E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \right. \\ \left. - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \right) U_{t+1}^p \end{array} \right] \\ &+ \beta E_t \left(1-\xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]. \end{aligned} \tag{69}$$

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^a:

$$J_t^p = a_t - w_t^p + \beta E_t \left(1-\phi\right) J_{t+1}^p, \tag{70}$$

$$J_t^a = a_t - w_t^a + \beta E_t \left(1-\phi\right) J_{t+1}^p, \tag{71}$$

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

$$w_t^a \in argmax \left(W_t^a - U_t^a\right)^\gamma \left(J_t^a\right)^{1-\gamma}, \tag{72}$$

which results in the following sharing rule:

$$\gamma J_t^a = (1-\gamma)(W_t^a - U_t^a). \tag{73}$$

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

$$w_t^p \in argmax \left(W_t^p - U_t^p\right)^\gamma \left(J_t^p\right)^{1-\gamma}, \tag{74}$$

which results in the following sharing rule:

$$\gamma J_t^p = (1-\gamma)(W_t^p - U_t^p). \tag{75}$$

The term on the right-hand side includes

$$
\begin{aligned}
W_t^p - U_t^p =& w_t^p - b + \beta(1-\phi) E_t W_{t+1}^p \\
& - \beta\left(1-\phi\right) E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
& - \beta\left(1-\phi\right) E_t \left(1-\xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]
\end{aligned} \tag{76}
$$

for the private wage and

$$
\begin{aligned}
W_t^a - U_t^a =& w_t^a - b^r + \beta(1-\phi) E_t W_{t+1}^p \\
& - \beta\left(1-\phi\right) E_t \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
& - \beta\left(1-\phi\right) E_t \left(1-\xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]
\end{aligned} \tag{77}
$$

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

$$
\begin{aligned}
V_{t+1} =& W_{t+1}^p - \xi_{t+1} \left[\begin{array}{c} -\hat{e}_{t+1} + \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) W_{t+1}^p \\ + \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) W_{t+1}^a + \\ \left(\begin{array}{c} 1 - \left(p_{t+1}^p - g_{t+1} q_{t+1}^a p_{t+1}^p\right) \\ - \left(p_{t+1}^a - p_{t+1}^a p_{t+1}^p\right) \end{array} \right) U_{t+1}^p \end{array} \right] \\
& - \left(1-\xi_{t+1}\right) \left[p_{t+1}^a W_{t+1}^a + \left(1 - p_{t+1}^a\right) U_{t+1}^a \right]
\end{aligned} \tag{78}
$$

such that

$$
W_t^a - U_t^a = w_t^a - b^r + \beta(1-\phi) E_t V_{t+1} \tag{79}
$$

and

$$
W_t^p - U_t^p = w_t^p - b + \beta(1-\phi) E_t V_{t+1}. \tag{80}
$$

Combining these expressions with the sharing rules (73) and (75) as well as the firms' values (71) and (70) we get the wage equations stated in the main text

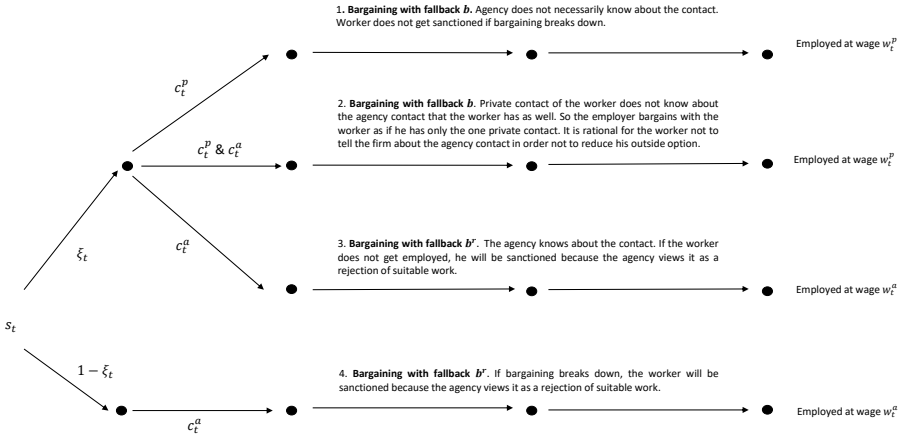
$$
w_t^p = \gamma a_t + \left(1-\gamma\right) b + \beta E_t \left(1-\phi\right) \left(\gamma J_{t+1}^p - \left(1-\gamma\right) V_{t+1}\right), \tag{81}
$$

$$
w_t^a = \gamma a_t + \left(1-\gamma\right) b^r + \beta E_t \left(1-\phi\right) \left(\gamma J_{t+1}^p - \left(1-\gamma\right) V_{t+1}\right). \tag{82}
$$

10 Appendix C: Details on Bargaining

Figure A1 shows the model assumptions and implications 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: Different Bargaining Outcomes.



Note: This figure shows fallback options and resulting wages for different scenarios.

11 Appendix D: Robustness of Numerical Results

11.1 Reform Complementarities or Substitutabilities

Table A1: Policy Responses: Last Reform

	$\Delta\psi^a$	$\Delta\eta$	$\Delta(a-b)$	Joint Effects
Unemployment	0.01	-0.30	-1.60	-2.35
Vacancy Share	-2.10	-1.05	4.57	2.36
Matching Share	-0.38	-0.31	-0.87	-1.98

Note: This table shows the joint (matched) effects of all three policy exercises (last column). The other columns show the individual effect of each exercise separately. All changes are in percentage points.

In addition to the effect of one reform step as the only change (Table 5), we calculate the effect of each reform step if it was the last change to happen (Table A1). To do this, we simulate the model with all three reform steps, remove one reform step and then calculate the respective difference for the three outcome variables. It can be seen that this reduces the unemployment effects for sanctions and the surplus shock. This can at least partly be explained by nonlinearities in the model resulting from the cost shock distribution. Although the cutoff point for search costs moves by a similar amount for the exercises in Table 5 and Table A1, the additional number of workers who use the private channel increases by less if the other exercise is in place. With a larger share of private searchers, the cutoff point moves into a thinner part of the idiosyncratic distribution.

11.2 Homogeneous Labor Market

As a second exercise, we look at a version of the model with only one search channel which we interpret as the agency. We then check if the results based on this version of the model are comparable to the results of Launov & Wälde (2016) if we follow their methodology in simplified manner. If we restrict workers to search via the public agency only, there is no second private search market. In different words, the Federal Employment Agency is the only intermediary/matching function in the economy. The model equations are:

$$
\begin{aligned}
m_t &= \psi s_t^{1-\alpha} v_t^{\alpha} \\
p_t &= \psi \theta_t^{\alpha} \\
q_t &= \psi \theta_t^{\alpha-1} \\
\theta &= \frac{v_t}{s_t} \\
\frac{\kappa}{q_t} &= a_t - w_t + E_t \beta (1-\phi) \frac{\kappa}{q_{t+1}} \\
w_t &= \gamma(a_t + \kappa E_t \beta \theta_{t+1}) + (1-\gamma) b \\
n_t &= (1-\phi) n_{t-1} + m_t \\
s_t &= 1 - n_{t-1} + \phi n_{t-1} \\
s_t^u &= 1 - n_{t-1}
\end{aligned}
$$

In this homogeneous model, we have to redesign our calibration exercise, as targeting the vacancy share and matching is not possible (by definition, they are equal to 100%). Note that we replicate the parametrization from the main part.

We follow Launov & Wälde's numerical strategy in simplified fashion (as our homogeneous model is less complex than theirs, e.g. in terms of unemployment durations). We take the increase of the matching efficiency from our reduced-form matching function in Table A4, namely 7 percent. We impose this increase in the matching efficiency on our model. This exercise yields a decline in unemployment of 0.65 pp. This number is comparable to Launov & Wälde (2016) who find a 0.88 pp decline (see their Table 2). In a second step, we use the 7% benefit reduction for long-term unemployed from Launov & Wälde (2016). To simulate this in our model, we multiply this change by 0.36 which corresponds to the average share of long-term unemployed in West Germany in the years from 1998 to 2003 ((Hochmuth et al. 2021),(vom Berge et al. 2013)). The result is a reduction of the unemployment rate by 0.11 pp which is comparable to the results of Launov & Wälde (2016) who find a 0.08 pp decline (see their Table 2).

Table A2: Policy Responses in a Simple Model

	$\Delta\psi$	Δb	Joint Effects
Unemployment	-0.65	-0.11	-0.75

Note: This table shows the effect on the unemployment rate of an aggregate matching efficiency increase and benefit cuts in a model with one search channel.

12 Appendix E: Data and Further Empirical Facts

12.1 Data

German Socio-Economic Panel:

As stated before, we construct the matching share of the agency from the German Socioeconomic Panel (SOEP). We also use it to get our target for the share of privately searching unemployed. The SOEP is a longitudinal survey covering approximately 30,000 individuals. For further descriptions of the SOEP, see Goebel et al. (2019). Since we use wave 35, we have observations from the starting year of the SOEP 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 SOEP. 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 actively 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 their current employment in the year of the questionnaire or in the year before. The construction of the time series shown in Section 3 and used as a target in Section 5 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 their job in a firm and individuals who switch to 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 these 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 4. The time series in Figure A4 is based on the same adjustments. Additionally, information from the SOEP spell data is used to obtain 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 from the IAB Job Vacancy Survey (Bossler, Gartner, Kubis & Küfner 2020, Bossler, Gürtzgen, Kubis, Küfner & Lochner 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 latter 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. When we construct qualification groups, the group university includes degrees from universities and universities of applied sciences.

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 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).

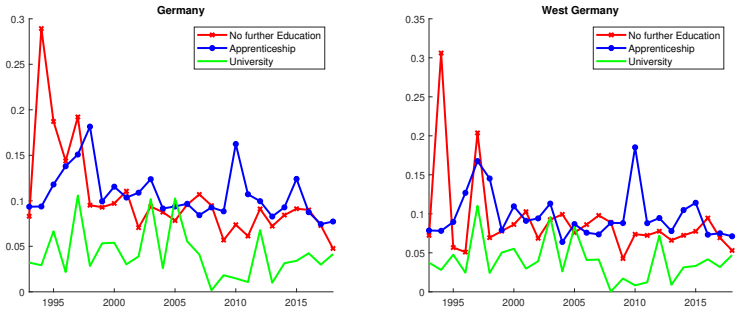
Baseline Sample:

Data from the IAB Job Vacancy Survey for West and East Germany is only available from 1992 onward. In addition, one key question for the construction of the matching share (on the job transition type, see Appendix 12.1) in the SOEP was rephrased in 1994. Because of the backward-looking nature of the underlying questions and the relatively large sample size in these years, we start calculating the matching share from 1993. Given these two restrictions, we chose the time period from 1993 to 2018 as our baseline. In addition, we do robustness checks based on a long sample from 1985-2018. Technically, it is possible to calculate the matching share also for the year 1984 since a share of respondents refers to positions started in the year 1984 when they are surveyed in the year 1985. Because of the small number of observations resulting from this, we chose to start the long time series in 1985, the first year in which the questions necessary were asked.

12.2 Vacancy and Matching Share: Robustness

Figure A2 shows the matching share for different education requirements for Germany and West Germany. This figure suffers from a small number of micro-observations per aggregate data point and is therefore somewhat more noisy that the aggregated figures. However, it is visible that the matching share (within certain groups) peaks in times of high unemployment.

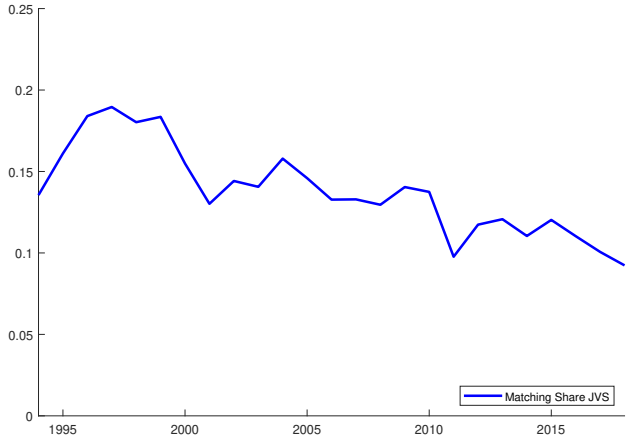
Figure A2: Matching Share for different Education Requirements



Note: The figure shows the matching share (based on SOEP) for positions with different education requirements.

Figure A3 shows the matching share based on the Job Vacancy Survey. Although the level of this matching share is somewhat larger, the dynamics is very similar to the SOEP-based matching share.

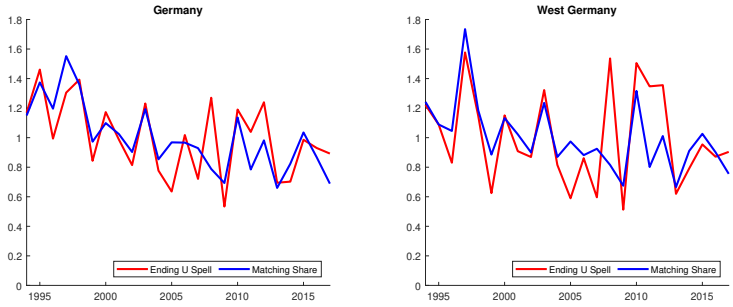
Figure A3: IAB Job Vacancy Matching Share



Note: The figure shows the matching share of the agency based on IAB JVS.

Figure A4 and Table A3 show further robustness checks with alternative definitions. The key patterns in the data are very robust.

Figure A4: Matching Share: Ending Unemployment Spell



Note: 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.

Table A3: 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 months 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.

12.3 Matching Function Estimations

Table A4 shows matching function estimations with shift dummys for the Hartz III reform. The left column shows a standard matching function estimation, based on the aggregate job-finding rate and market tightness. The right column shows the estimation for a public matching, based on agency matches and agency market tightness. While there is a positive and statistically significant coefficient on the aggregate shift dummy, the estimated coefficient is negative and not statistically significant for the agency.

12.4 Probability of Being Matched via the PEA

Table A5 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 SOEP.

Table A4: 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 19.

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 A5: 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 from West Germany are included. We only use observations from our baseline periods from 1993 until 2018.